MECHANICAL ENGINEERING

October 1961

SPECIAL FEATURE

37 Equipment for Ultrahigh Pressures

A STATE-OF-THE-ART REPORT ON HOW EXTREME PRESSURES ARE ACHIEVED FROM WHICH MAY COME NEW MATERIALS FOR THE ENGINEER

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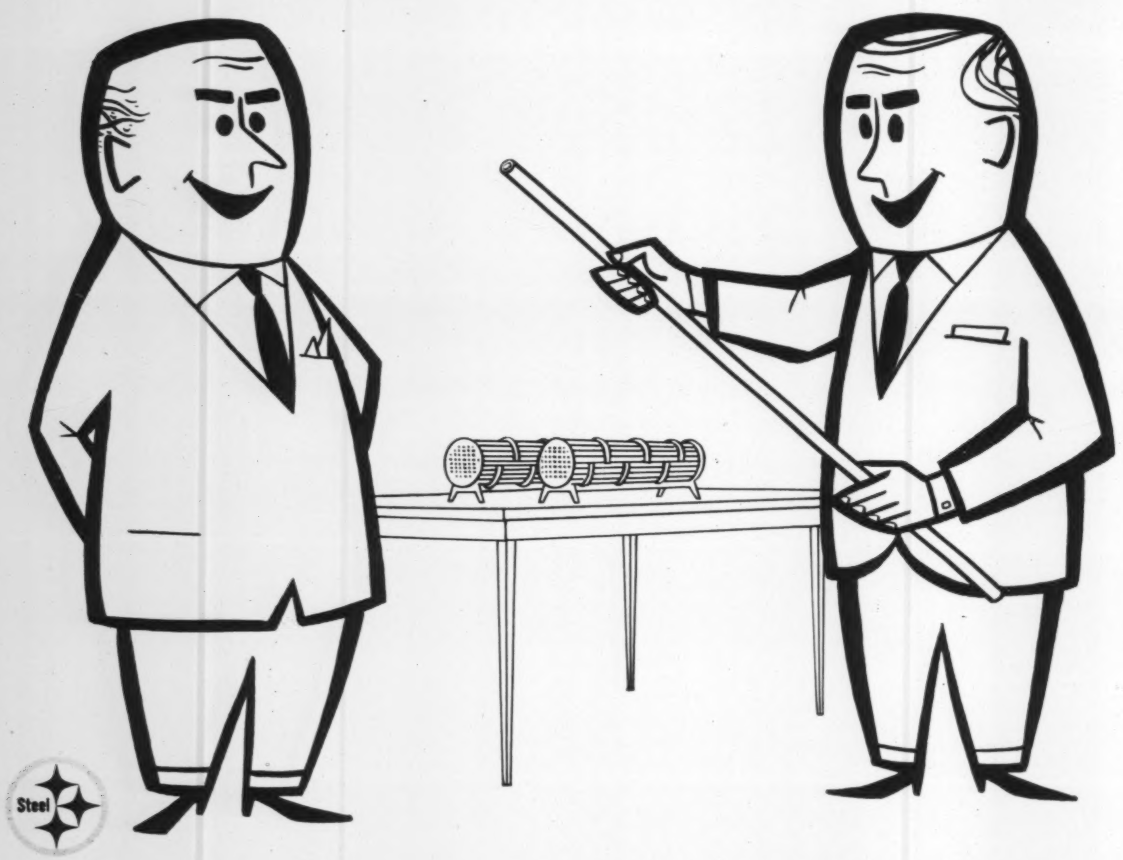

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A Nalco DEPARTMENT MANAGER

Answers the Questions Most Often Asked About Nalco Water Treatment Consulting Service

Experts Extend Your Staff Potential for Fast, Economical Handling of System Design, Chemical and Equipment Selection, and Plant Operations.

Question: If a company's staff includes qualified design and operating personnel, why is Nalco Consulting Service needed?

Answer: Design, modification, improvement, and achievement of maximum economy in operation of water treatment facilities are highly specialized chemical engineering fields. Constant research and long experience in these fields enable Nalco engineers to supplement–*not* replace–the efforts of a company's staff by providing up-to-date information in their special fields.

Question: How does Nalco Consulting Service differ from the services of design consulting engineers?

Answer: Again, remember the specialized nature of water treatment engineering. Rarely can a company or consulting firm afford to maintain a staff of engineers who devote their entire energies to water treatment. Nalco, however, *does* have such a group of water treatment specialists that can act as an extension to the staff of the design engineer. These men have not only knowledge and experience in the intricacies of each of the specialized areas of water treatment, but the constant association with the rapidly changing technology of the field required to keep their information accurate and up-to-date.

Question: What return on investment does the cost of a Nalco consulting program provide?

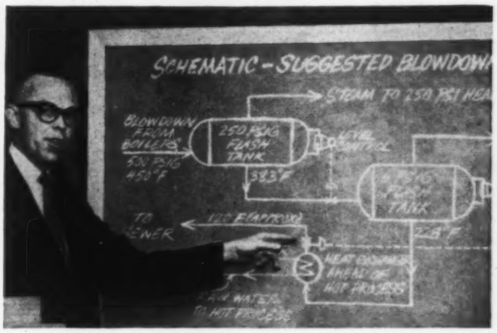
Answer: Nalco Consulting Service reduces plant construction costs and saves *your* engineers' time. For example, assume that you need a new or completely modernized ion exchange water treatment plant. Nalco Consulting Service will help your engineers and/or design consultants establish the basic type and size of plant needed, *before* requests for bids are issued. Potential suppliers can then return bids faster and more economically. Also, your engineers can evaluate bids in a fraction of the time required for evaluation of bids on a variety of plant types. This reduces the overall cost of the system and releases the men involved for other projects.

Question: How is Nalco Consulting Service useful to an existing plant for which no immediate expansion is planned?

Answer: Few plants require or can afford a *full-time* water conditioning engineer – yet *all* plants find at times that they need the services of such an engineer. Nalco meets this need by supplying plant operators with the assistance they need, when they need it, to an extent determined by mutual agreement. Consulting service prevents many problems before they occur by anticipating the need for changes in chemical treatment control and application–giving you maximum benefit from every dollar spent on water treatment chemicals.

Question: Isn't consulting service usually supplied, free of charge, with the purchase of water treatment chemicals?

Answer: *Product application assistance* is offered for specific chemicals. Consulting provides an overall *program*. The complexity of many of today's systems requires attention to all phases of operations. While product application assistance is an important Nalco service to industry, often it should be supplemented with a consulting arrangement which provides the intensive and effective integration of *all* water treatment into a successful program.



Selden K. Adkins, Manager, Nalco Consulting Service Department

Question: What do you mean when you say "the highly specialized nature" of chemical engineering as applied to water conditioning?

Answer: No one engineer can know every single detail that is important in each phase of an overall water treatment program. Coagulation, filtration, stabilization, softening, sludge conditioning, ion exchange, slime and microbiological control–all these and many more must be considered. Nalco's coagulation, stabilization, power industry chemicals, process antifoams, cooling water, and microbiology departments maintain an effective working knowledge of each of these special areas of water treatment. Each department manager is an expert in his given field, and is assisted by an average of 25 staff and laboratory personnel. Nalco's Consulting Department draws on the specialized knowledge of each of these groups to provide the engineering knowledge needed in each plant. By coordinating the efforts of all these specialists and utilizing the knowledge and experience of our national field force. Nalco can provide precise information to get successful results. That so many departments are vital in our operations indicates the degree of specialization necessary.

Question: How can a company that sells chemicals be a "true" or impartial consultant?

Answer: Regardless of affiliation, consultants are responsible for producing effective results. Nalco consultants have nothing to gain–and everything to lose –by recommending any chemical or method not in the best interest of the client. Water treatment products offered by Nalco (or any reputable company of this type) are usually special blends, each designed to do a specific job under a specific set of conditions. These specialized products would not exist if there was an *exact* equivalent "open market" chemical available. The Nalco Consulting Department recommends the most suitable chemical for a given situation–regardless of whether or not it is a Nalco product. The single objective of Nalco Consulting Service is to provide the client with maximum treatment efficiency, regardless of which chemical or equipment is used. Chemicals are no more than tools to the consulting engineer–what he provides are programs, methods, and results.

Suggestion: Ask your Nalco Field Representative, or write for illustrated 16 page Bulletin D1 for information on Nalco Consulting Services.

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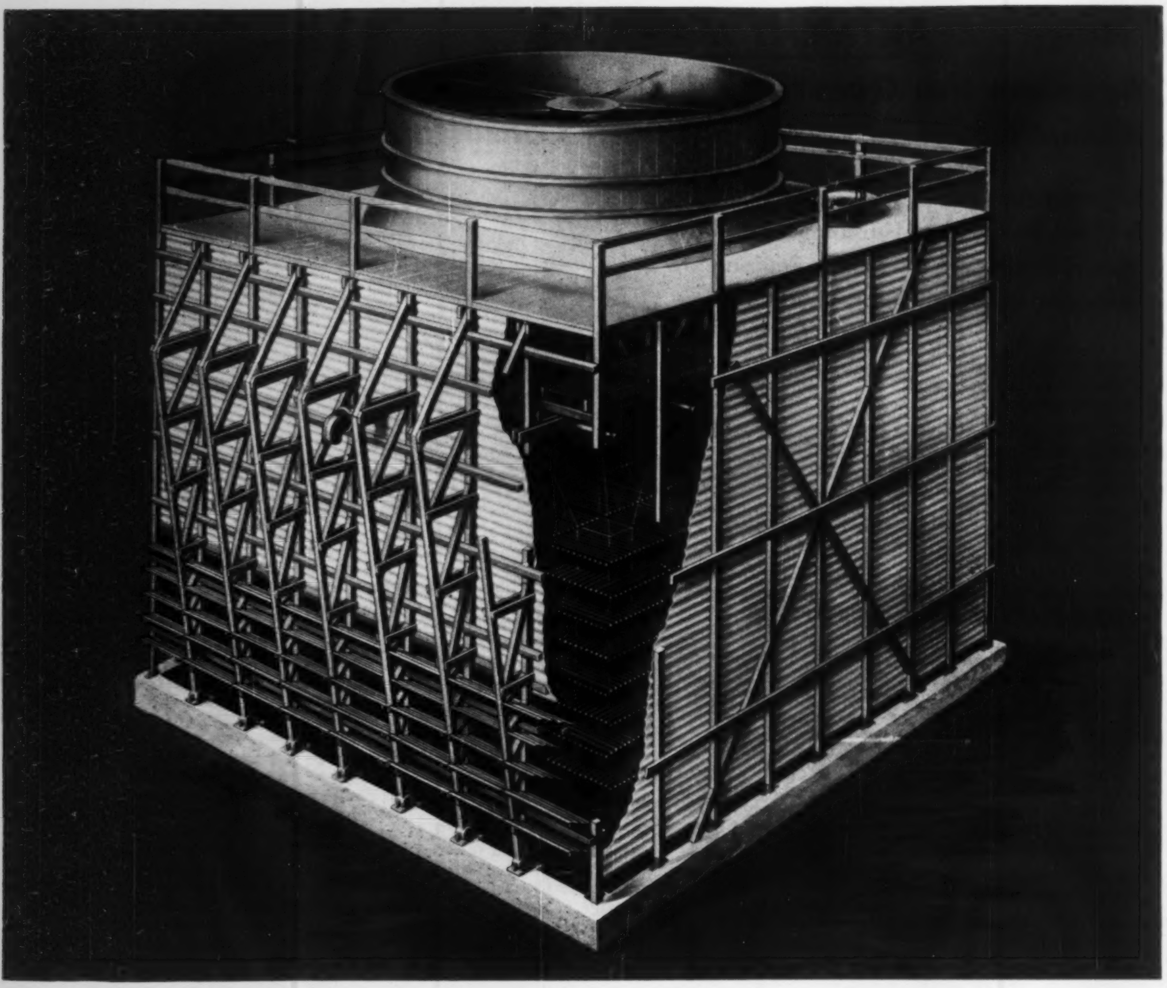

New idea...no structural internals

The *interior* of this new Foster Wheeler cooling tower is *completely free of structurals* below the roof trusses.

It is Foster Wheeler's new Rigid-Bent design featuring tapered built-up columns outside the tower sheathing, away from the moist, corrosive atmosphere within.

In every application, particularly where water chemistry and biological attack are serious problems, the FW Rigid-Bent design offers . . . isolation of vertical structurals from corrosion and biological attack . . . and uncommon ease of inspection, maintenance and replacement of all parts.

Space requirements and operational characteristics are the same as those attainable with older designs. Increased capacity by the addition of cells is no problem. Structurals are easily inspected and repaired during tower operation.

If you are currently considering an installation, let us provide you with further information. Write to Dept. CT, Foster Wheeler Corporation, 666 Fifth Avenue, New York 19, New York.

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All tower internals are suspended from roof trusses. Cable-hung fill racks are quickly lowered to ground level for inspection and maintenance.

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THE COVER

An expression of the engineer's pride in his profession, the just-finished United Engineering Center is the national headquarters for more than 300,000 engineers in the five Founder Societies, of which ASME is one—and many others—a total of 19 engineering societies. Here, also, is the Engineering Societies Library, believed to be the world's most complete collection of engineering literature. The UEC is, for us, a healthy step forward in the 80-year development of ASME. See "Headquarters, ASME," pp. 106–109, and the Editorial, p. 33.

PRODUCTIVITY IN THE FUTURE..........................**W. F. S. Woodford** **34**

Brace yourself: Some of the ideas expressed here shape up as unconventional, maybe even preposterous—such as year-long vacations in the age of automation. But don't bet against any of them.

EQUIPMENT FOR ULTRAHIGH PRESSURES.............**Alexander Zeitlin** **37**

In 1909, a young scientist began experimenting with extreme high pressures. Result: For Bridgman, a Nobel Prize for Physics; for us, new research tools. What kind of equipment is used today?

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Keeping up on atomic power? You'll want to know about the SSCR, a variation of the pressurized-water-reactor concept. Reactivity is steadily changed to offset burnout and isotope buildup.

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First came mechanically driven "shakers" for studying the effects of vibration in aircraft. Now, we have electrodynamic exciters capable of reproducing random vibrations for testing of rockets.

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SIGMA's GS-34 free-piston engine, described in Mechanical Engineering for May, 1957, became the power source of choice for a station in remote New Caledonia. Here's the detail on the installation.

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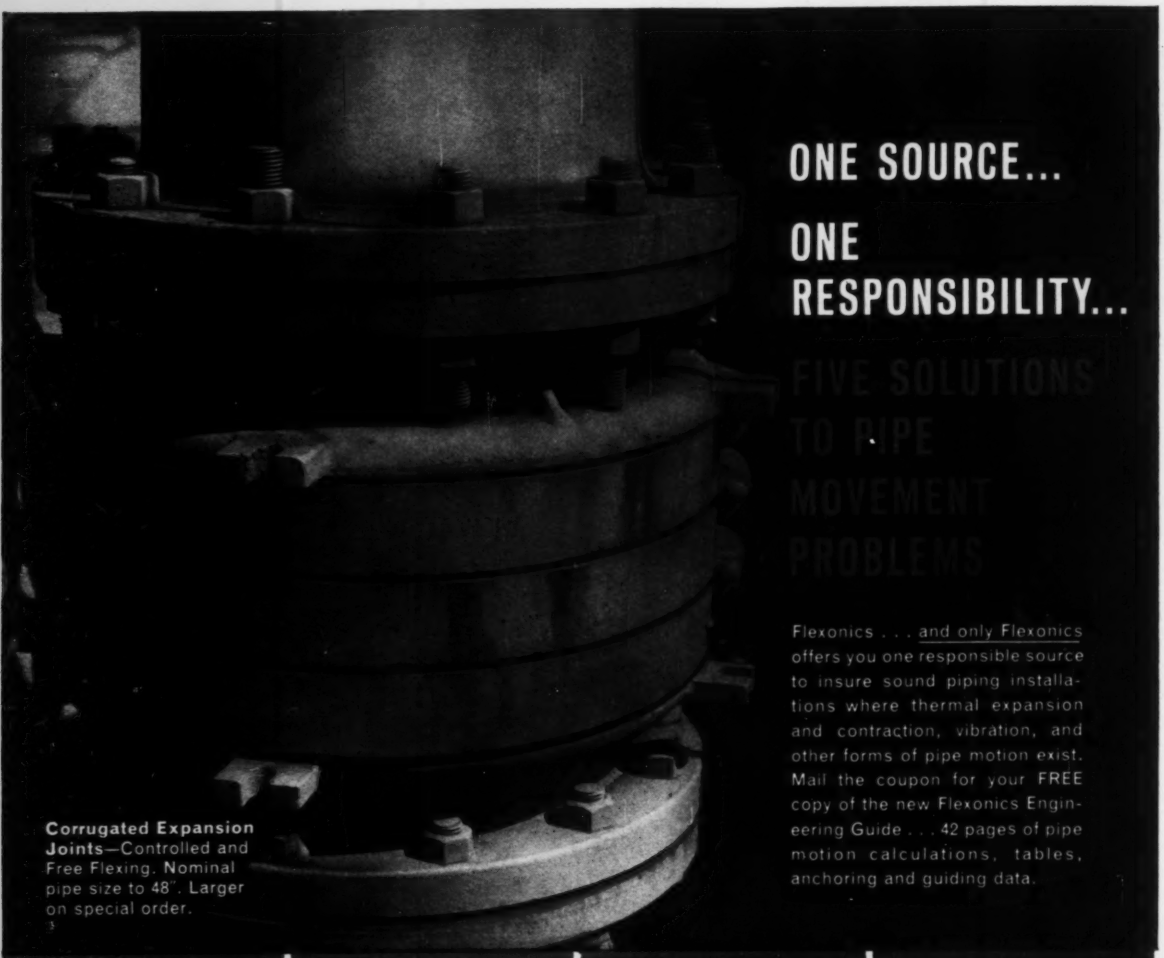

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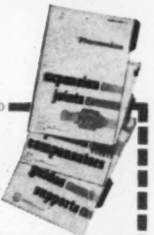

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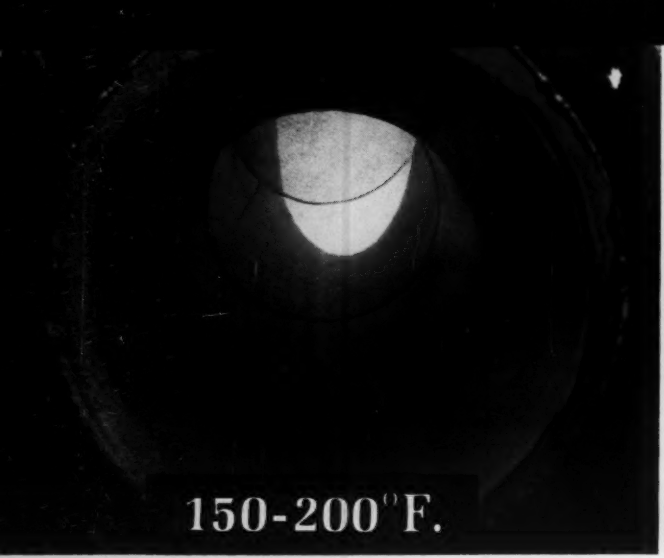
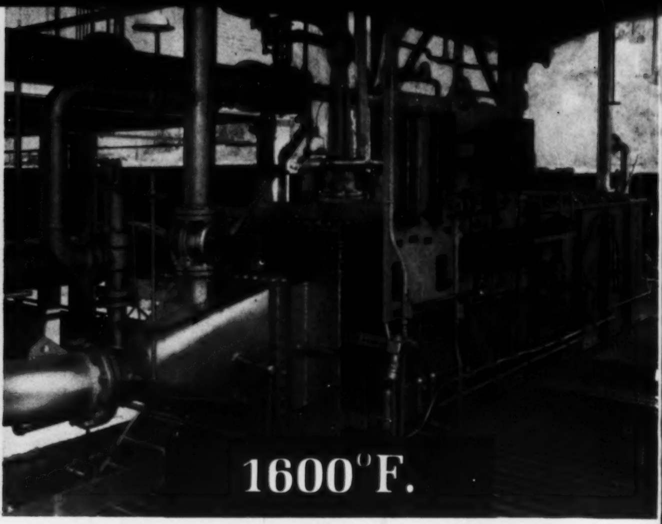


REFRACTORY-LINED PIPE RESISTS ABRASIVE BLAST

This silicon-carbide-lined elbow in air conveying system shows no pitting or other wear after 2½ years. Rubber liners previously used were cut through in less than six months by finely divided cement and asbestos particles in the hot air stream. Exceptional wear resistance of Carborundum's silicon carbide refractories makes them ideal for use wherever severe abrasion is encountered, as in dust collectors, blast furnace down-comers, tees and ells in pipe lines.



GAS REFORMER ATTAINS 97% EFFICIENCY WITH ALUMINUM OXIDE CHECKERS

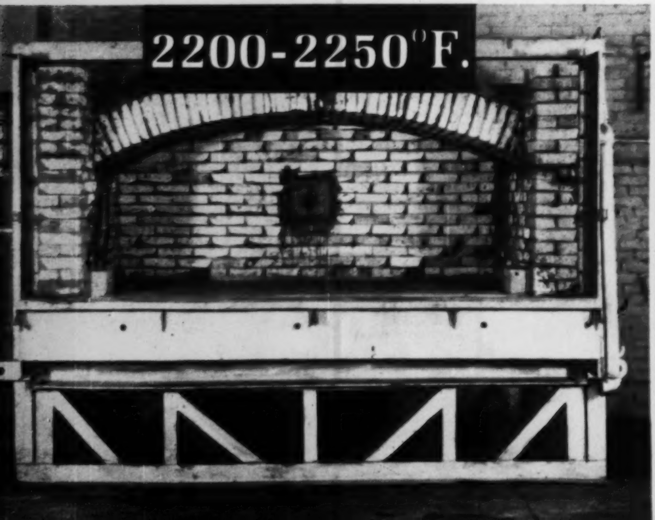
Fluted ALFRAX® Al_2O_3 checkers are laid face to face forming small parallel flues in the gas reformer unit. High specific heat and density of the fused aluminum oxide checkers provide an ideal heat-storage mass. Their chemical stability and purity prevent destructive reactions. Typical gases reformed are propane, butane and natural gas at maximum gas temperatures of about 1600°F. Conversion efficiency is 97%.

Report from Carborundum:

How specialized refractories excel

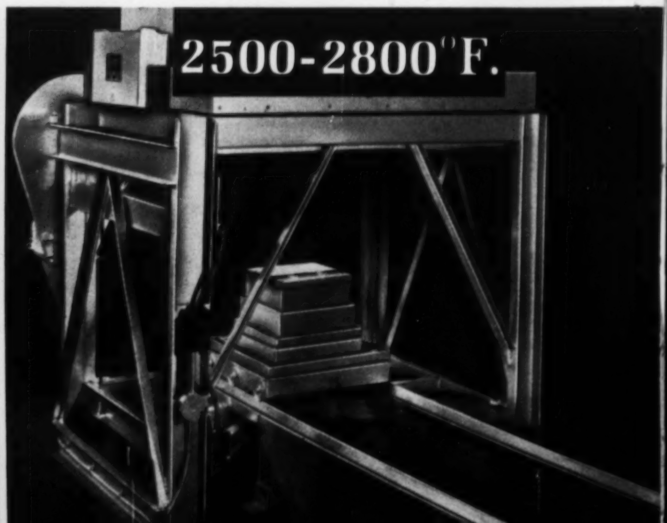
HEATING CYCLE IS CUT BY ONE-THIRD

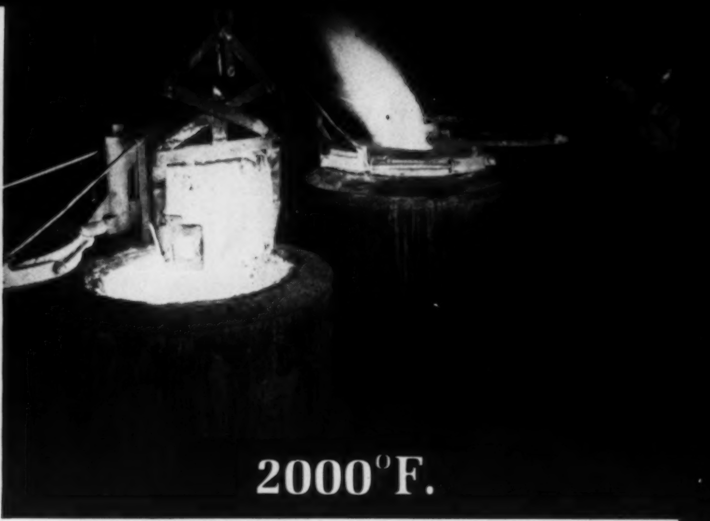
By changing from a firebrick lining to ALFRAX® BI "bubble brick," heating cycle of this slot-type forge furnace dropped from 45 minutes to 30 minutes. This refractory offers high temperature resistance, thermal insulation and load-carrying ability. It is installed in the front, side, and back walls and arch. Silicon carbide brick are used in the floor. Furnace is oil-fired, operates five days a week without shutdown. Materials give 12-18 months service.



REFRACTORY TILE TAKES HEAT SHOCK

Powdered metal parts are raised into this sintering furnace on an "elevator." The parts are placed on a CARBOFRAX® tile on top of the lift. The tile fills the need for high resistance to thermal shock and provides a hard, dense surface. Chamber is lined with ALFRAX® BI aluminum oxide brick, used for low heat capacity, high refractoriness and good thermal insulating value.





SKID RAILS CARRY TONNAGE LOADS WITH MINIMUM WEAR

After one year, these CARBOFRAX® silicon carbide skid rails still looked good as new, though they had carried 16,500 tons of forging billets. Four months later during a shutdown period the total wear was measured as 1/16". Compare this record with the two-weeks service obtained from a rammed chrome hearth. Each replacement required furnace shutdown which, in turn, cut output. Temperature rise through pusher-type furnace is 1400°F.

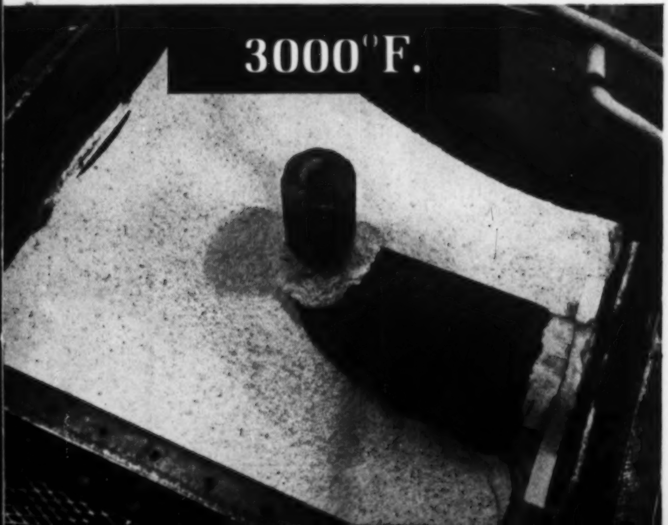
CRUCIBLE LINING FOR Al-Cu ALLOYS HAS LONG LIFE

Each of these crucible furnaces is equipped with a CARBOFRAX® block-type lining. The individual silicon carbide shapes are tongue-and-grooved for strength and stability and are easily installed. Long life of the blocks eliminates frequent patching and permits steady, reliable operation. Clinkers do not form, so that heat radiates uniformly from linings to crucible. The coke-fired furnaces are used to melt high-quality aluminum bronze.

in low to high temperature jobs

THIN-WALLED MUFFLE IS RUGGED, STABLE

This furnace operates up to 3000°F in a hydrogen or cracked ammonia atmosphere. Heat source is a moly ribbon wrapped around an ALFRAX® PK muffle and then coated with insulating cement. Even with its thin walls, power requirements are not excessive. The aluminum oxide muffle is rugged, dimensionally accurate and has long life. Fused alumina "bubbles" piled around muffle are used to insulate the furnace.



Want help on your problems?

Carborundum engineers will be glad to recommend refractories to answer your specific needs. For information, contact Dept. ME-101, Refractories Division. The Carborundum Co., Perth Amboy, N. J. Descriptive brochures available on request. Please specify the area or areas of particular interest to you.

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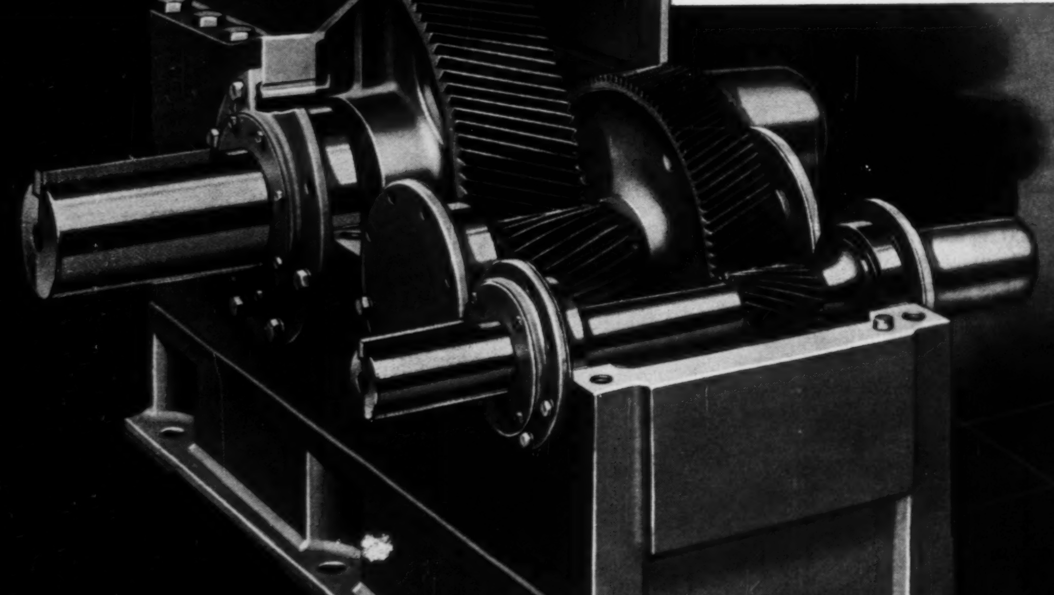
(write for Bulletin 2100)



Type Y Parallel Shaft
(write for Bulletin 1100)

Parallel Shaft and Right Angle Horizontal Reducers cataloged thru 1,570,000 lb-in. torque at low speed shaft …larger units upon request. Ratios 1.84 thru 292 to 1 for parallel shaft; 5.06 thru 1207 to 1 for right angle horizontal

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These new units are probably the most thoroughly engineered speed reducers on the market today. Final designs based upon years of development study and a background of 50 years experience make these units as dependable as the name "FALK". A few of their many features are….

PINPOINT APPLICATION COVERAGE Wide choice of sizes and ratios permits the most economical selection of a correctly rated unit for each application. In each series of parallel shaft and right angle reducers, cataloged sizes range up to 1,570,000 lb-in. torque at the (11 inch dia.) low speed shaft. (Other standard designs to 25,000,000 lb-in. torque; custom designs for higher capacities.)

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RUGGED HOUSINGS Sturdy housings not only provide maximum rigidity to maintain proper alignment of gearing, but also have the strength to support heavy overhung loads and withstand accidental blows.

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BEARINGS TO SUIT THE OVERHUNG LOAD Standard reducers can meet custom-built requirements with optional stock bearings and shafts (at only a nominal extra charge.) Maximum overhung load capacities are so great that for some conditions, still within the capacity of the reducer, extra strong supporting foundations and bolts must be provided.

DOUBLE GEAR LIFE Standard double ended shafts can be reversed end for end to bring into contact the unused surfaces of the gear teeth for twice the normal gear life.

SEALS FOR ALL CONDITIONS Standard equipment oil seals assure oil-tight and dirt-free gear units for normal applications. Standard abrasive and moisture-resistant seals available upon order.

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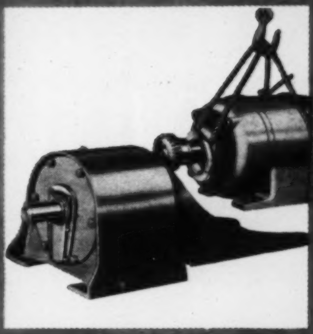
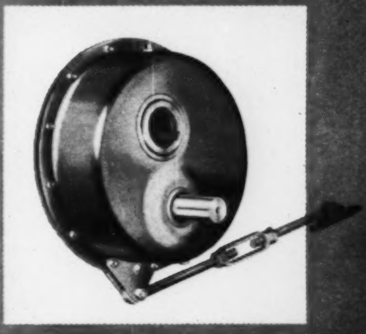
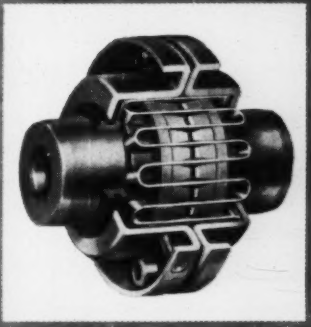


ALL-MOTOR MOTOREDUCERS



SHAFT MOUNTED DRIVES



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new nuclear plants choose

FULFILLS THE EXACTING

HEAT EXCHANGERS

[illegible] stainless steel castings readied for shipment by U.S. Pipe

The Government's new SPERT III nuclear plant at the National Reactor Station near Idaho Falls, Idaho, operating since December, 1958 to study nuclear reactor safety, uses U.S. Pipe's centrifugally cast stainless steel pipe for its coolant system.

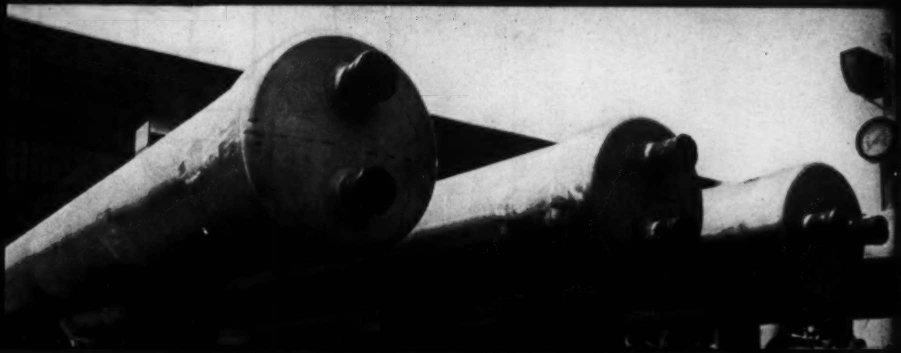
SPERT III is classified as a high pressure, high temperature, light water moderated and cooled reactor. Its versatility permits transient tests under various initial conditions of pressure, temperature, and coolant flow. For example, pressures ranging from atmospheric to 2,500 psi and water temperatures from 68° to 668° F.

Another new nuclear power plant, engineered and constructed by Stone & Webster for Yankee Atomic Electric Company, is using centrifugally cast stainless steel heat exchanger shells made by U.S. Pipe and fabricated by the Southwestern Engineering Company in Los Angeles, Calif.

Stainless steel, centrifugally cast, made to rigid specifications, may be the answer to your piping or heat exchanger problem. For more information, write or call:

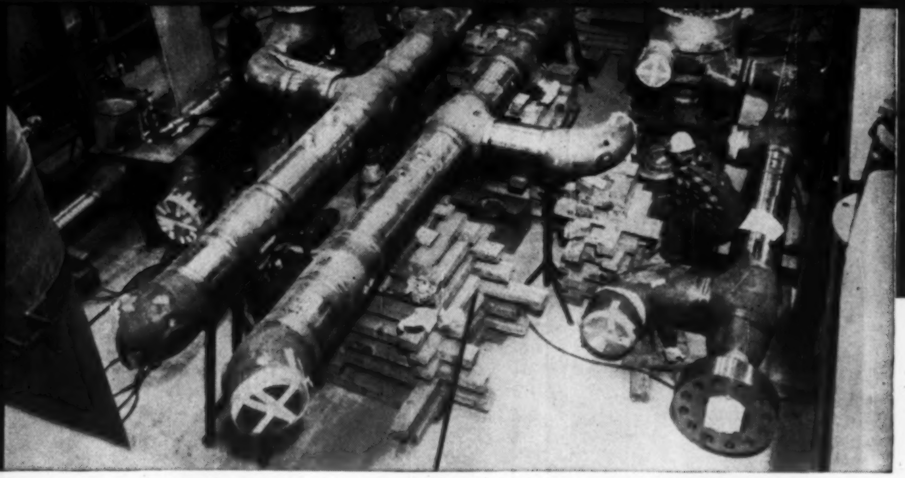
centrifugally cast stainless

REQUIREMENTS OF NUCLEAR AND COOLANT SYSTEMS



Shop-fabricated heat exchanger shells of centrifugally cast stainless steel ready for shipment to the Yankee Atomic Electric plant at Rowe, Mass.

Subassemblies of primary coolant piping of centrifugally cast stainless steel being installed in SPERT III.



ASA PRESSURE PIPING CODE STATUS

Approval has been granted under ASA Code for the use of centrifugally cast austenitic pipe for nuclear piping by Nuclear Case N-2. This case appeared in the April, 1960 issue of [illegible], [illegible]. Reprints on request.

UNITED STATES PIPE & FOUNDRY CO.

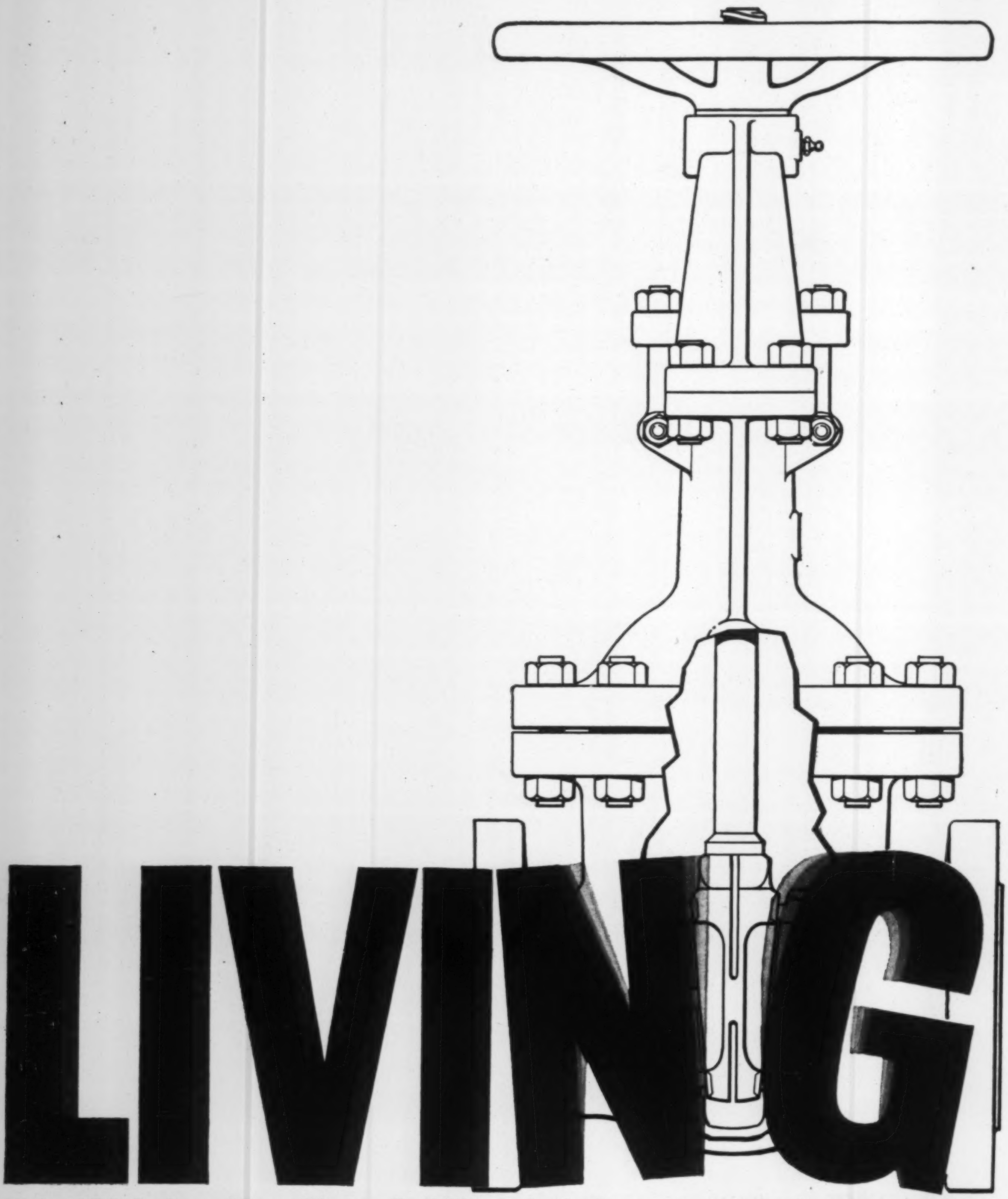
Steel and Tubes Division

STEEL & TUBES U.S. PIPE DIVISION

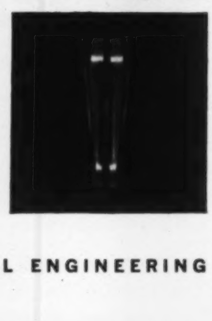
BURLINGTON, NEW JERSEY

SALES OFFICES: BURLINGTON, HARTFORD, BIRMINGHAM, CHICAGO, CLEVELAND, DALLAS, LOS ANGELES, NEW YORK, PITTSBURGH, SAN FRANCISCO

Circle No. 130 on Readers' Service Card



LIVING



Walworth's last word in positive sealing! When valve bodies are tortured out of shape by line pressure, temperature or deflection—new Walworth living wedge Gate Valves still seal tight! It's because of Walworth's unique one-piece split disc gate that lives in the body...flexes and gives, to stay mated to the seat in spite of body distortion. Yet new Walworth living wedge Gate Valve operates at low torque, can't bind, jam or stick—and is economical, needing

WEDGE

minimum replacements. Get new Walworth living wedge Gate Valves in 150 and 300 pound ASA ratings, 2" to 24". See your Walworth distributor for details, or write to Walworth Company, 750 Third Avenue, New York 17, N. Y.

WALWORTH

the Walworth companies: Alloy Steel Products Co.—Conoflow Corporation—Grove Valve and Regulator Co.—M & H Valve and Fittings Co.—Southwest Fabricating & Welding Co., Inc.

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new
SERVO CONTROL

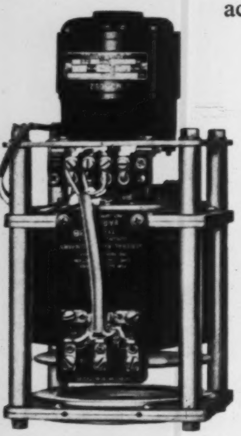
Positions and Monitors Remote Variacs

50
100
0
150
AC VOLTS
ON
OFF
POWER
REMOTE CONTROL
TYPE 1590-A
INCREASE
VOLTS
INT
EXT
INPUT 120 VOLTS
50-60 CYCLES
SERIAL NO INSIDE
GENERAL RADIO COMPANY
CONCORD MASSACHUSETTS USA

The new 1590-A Remote Control positions motor-driven Variac® autotransformers from a distance. The Control is a servo — the output voltage from the remote Variac is automatically held to the value set by a Variac in the Control Unit. Moreover, if the line voltage supplied to the Control Unit is held constant, the remote Variac can be used as a source of continuously adjustable *regulated* voltage. Correction speed is fast . . . up to 60 volts per second for small 2- and 5-ampere autotransformers.

Other features include: Continuous monitoring of output voltage by meter . . . ability to control 120-volt Variac autotransformers of any size . . . where continuous monitoring and control are not required, one 1590-A can be switched to control any number of remote units individually . . . a built-in circuit breaker protects unit from damage . . . the control is completely passive — with no active elements, reliability is high.

Tracking accuracy of the system is ±2% of input line voltage when used with motor speeds listed in table (halving speed increases accuracy to ±1%). Price of the Control Unit is $95.



Motor-driven, basic Variacs range from $108 to $272.

REMOTE VARIAC TO BE CONTROLLED	SINGLE UNIT				TWO-GANG		THREE-GANG	
	Amperes Rated	Amperes Max.	Traverse Time (Seconds)	Approximate Correction Rate (Volts/Sec)	Traverse Time (Seconds)	Approximate Correction Rate (Volts/Sec)	Traverse Time (Seconds)	Approximate Correction Rate (Volts/Sec)
W2	2.4	3.1	2	60	2	60	4	30
W5	6.0	7.8	2	60	4	30	8	15
W10	10.0	13.0	4	30	8	15	16	8
W20	20.0	26.0	8	15	16	8	32	4
W30	30.0	36.0	16	8	32	4	32	4
W50	50.0	50.0	32	4	64	2	64	2

For control of 3-gang W30 and W50 Variacs, tracking accuracy is 3%.

GENERAL RADIO COMPANY
WEST CONCORD, MASSACHUSETTS

NEW YORK, WOrth 4-2722
District Office in Ridgefield, N. J.
WHitney 3-3140

CHICAGO
Oak Park
VIllage 8-9400

PHILADELPHIA
Abington
HAncock 4-7419

WASHINGTON, D.C.
Silver Spring
JUniper 5-1088

SAN FRANCISCO
Los Altos
WHitecliff 8-8233

LOS ANGELES
Los Angeles
HOllywood 9-6201

IN CANADA
Toronto
CHerry 6-2171

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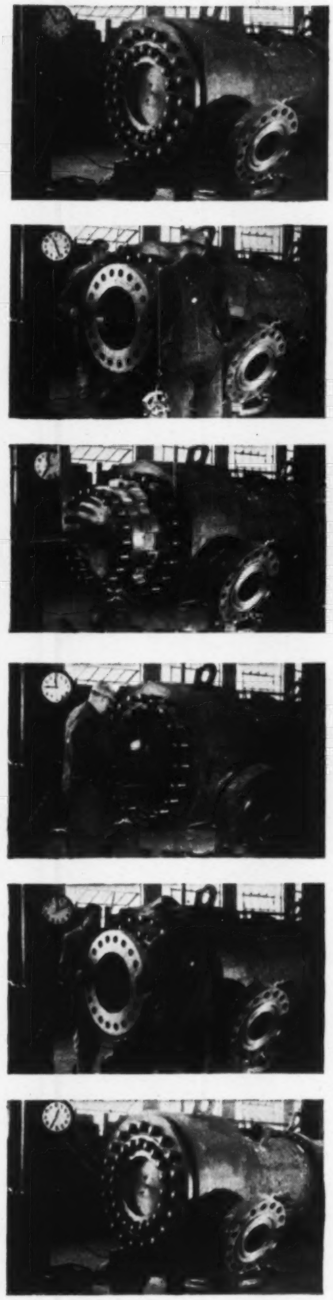
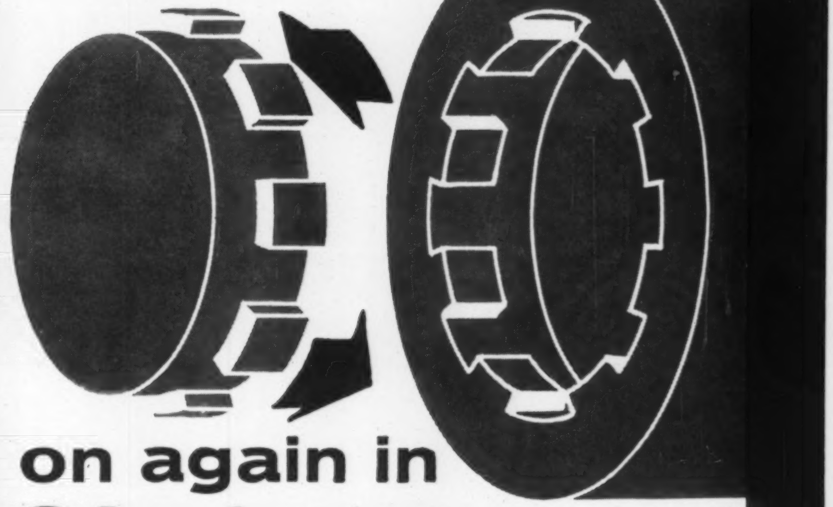


head cover off and



on again in 84 minutes

cuts feedwater heater inspection downtime

Periodic internal inspection of high pressure feedwater heaters is easy and fast with G-R Type "L" breech block heads. The complete operation of cover removal and reinstallation is shown in photographs at left.

When the cover is removed the entire tube sheet and all tube joints are readily accessible for examination and cleaning from outside the heater. No need to squeeze and squirm inside the water head whether heaters are large or small.

G-R Type "L" breech block high pressure heaters are available with all welded seals without gaskets, with rolled or rolled-and-welded tube joints.

More than 1,000 G-R heaters are installed operating at over 1,000 psi. More than 250 are in operation at pressures in excess of 3,000 psi. *This record is unsurpassed by any other American manufacturer.*

G-R high pressure heaters are available in all types and sizes, horizontal or vertical, and are furnished with suitable cover handling rigs.

Take advantage of G-R's extensive experience in the design and fabrication of Feedwater Heaters. There is a G-R representative in your territory ready to help you.

GRISCOM-RUSSELL / C. H. WHEELER

Massillon, Ohio — Philadelphia 32, Pa.

Affiliated sources for heat exchangers, closed feedwater heaters, deaerating heaters, evaporators, steam condensers, pumps, marine auxiliary equipment, sea water distillation plants, nuclear steam generators and related components.

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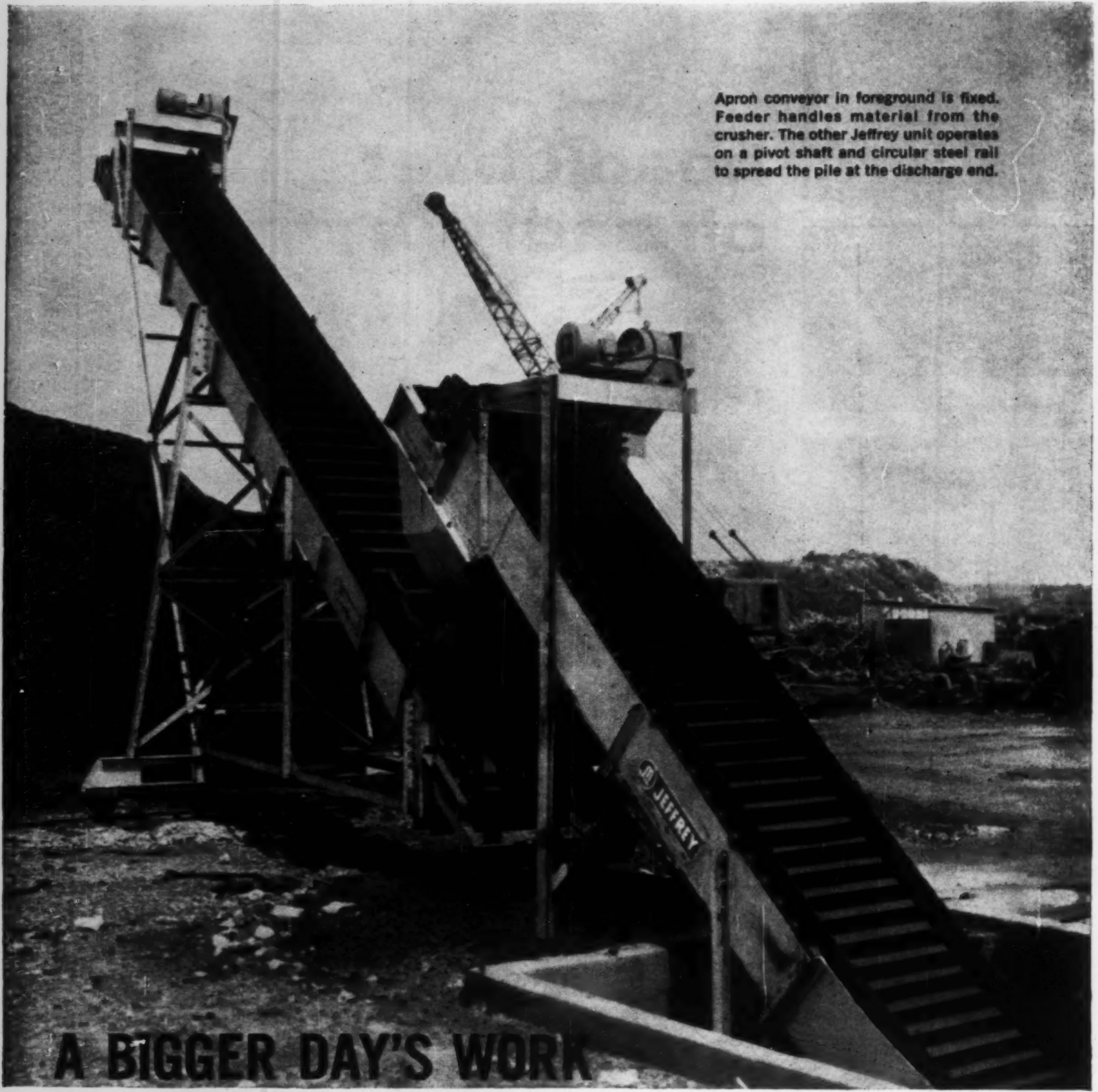


Apron conveyor in foreground is fixed. Feeder handles material from the crusher. The other Jeffrey unit operates on a pivot shaft and circular steel rail to spread the pile at the discharge end.

A BIGGER DAY'S WORK BEGINS WITH JEFFREY CONVEYORS

Take Chas. J. King, Inc. of Brooklyn, New York, for example. Two Jeffrey 36″ Hinged Apron Conveyors handle crushed, shovel-size metal turnings—at a rate of 50 tons per hour. The turnings weigh 50 pounds per cubic foot and are transferred at a rate of 60 feet per minute. That's moving—in anyone's language.

The aprons are made of steel flights on Jeffrey STR Chain. Each flight is fitted with a lifting blade. Units come complete with steel frames, chain drives, reducers and 3 hp motors.

Get a bigger day's work! Get the facts on Jeffrey conveying equipment today. Competent engineering facilities and service help assure satisfaction every time. For more information, write for Catalog 980, The Jeffrey Manufacturing Company, 915 North Fourth Street, Columbus 16, Ohio.

If it's conveyed, processed or mined, it's a job for Jeffrey **JEFFREY**

Circle No. 72 on Readers' Service Card

AT ASTORIA...

CON EDISON EXPECTS

FUEL SAVINGS OF 8% FROM FOUR NEW LJUNGSTROMS®

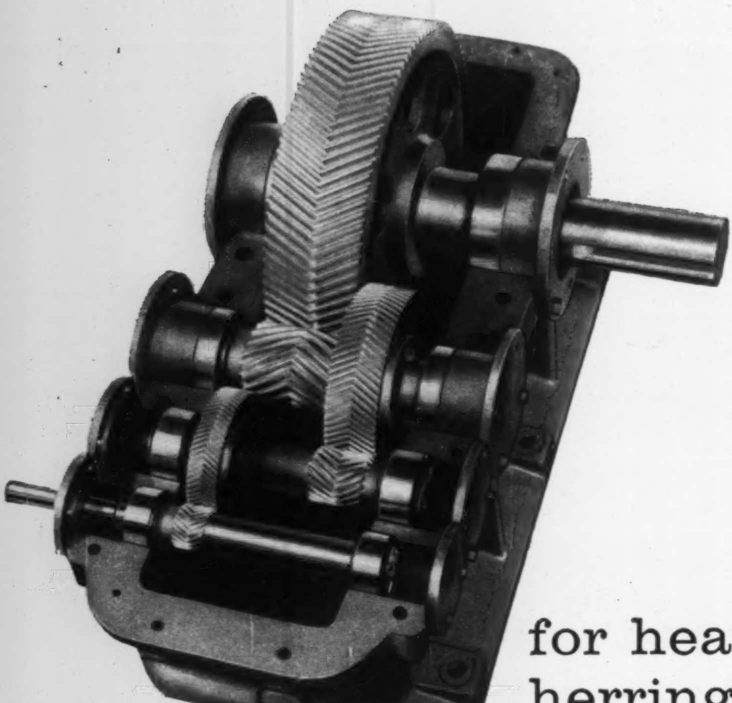
Four new Ljungstrom Air Preheaters are being installed by Consolidated Edison Company of New York, Inc., on their Astoria Stations' #50 boiler unit. With a total heating surface of about 547,000 sq. ft., these four units are designed to reduce the stack temperature 345° F. By transferring this heat to the incoming combustion air, a fuel savings of about 8% is realized. Addition of these units makes a total of 16 Ljungstroms installed at Astoria . . . 77 either installed or on order in the entire Con Edison system.

Our engineers will be glad to recommend ways to improve your operating results on new or existing fuel fired units. For information, please write to:

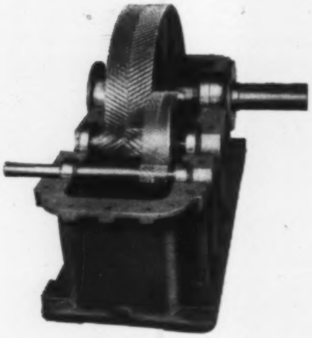
Circle No. 4 on Readers' Service Card

THE AIR PREHEATER CORPORATION

60 East 42nd Street, New York 17, N.Y.

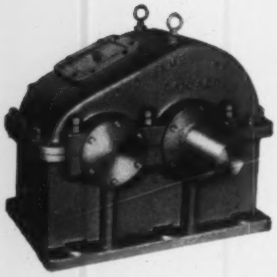


Parallel shaft offset drive, triple-reduction unit.



Parallel shaft offset drive, double reduction. Also available with in-line drive design.

for heavy loads, use herringbone reducers



Parallel shaft offset drive, single reduction.

When you require heavy-duty drive units, D. O. James herringbone gear reducers provide unequaled advantages:

Strongest tooth form — due to the arch-like construction of the tooth and large 30° helix angle.

Greatest load-carrying capacity — large multiple-tooth contact in plane of action — full width of the tooth face is utilized.

No side thrust — thrusts of the opposing helices tend to balance each other, distributing load evenly across the face of tooth. Housing is economical because no provision for side thrust need be made, nor are thrust bearings required.

Improved splash lubrication — an oil film is formed and preserved by the wedging action of the teeth.

High efficiency — 98% on single reduction units.

These reducers are made in 110 standard sizes, single, double, and triple reduction, 2:1 to 370:1 ratios, .5 to 5000 hp.

For complete information, call your D. O. James representative or write today. Ask for Catalog 40-E.

D. O. JAMES GEAR MANUFACTURING CO. 261
1140 West Monroe Street, Chicago 7, Illinois
Since 1888, every type of cut gear and gear reducer

D.O.James

...where you always get good gearing

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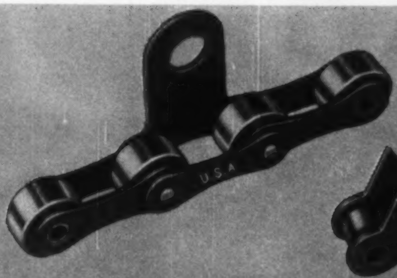

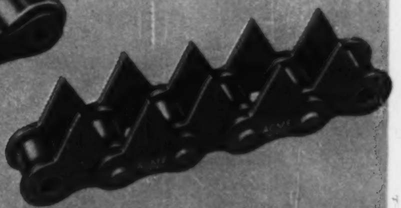

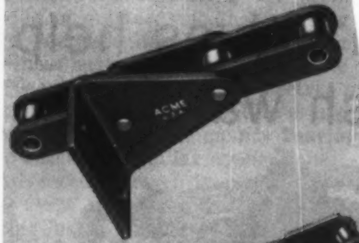

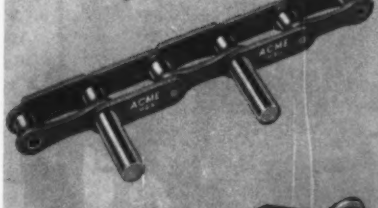

HOW ACME'S SPECIALLY DESIGNED ATTACHMENTS SAVE YOU MONEY

These are just a few of the hundreds of conveyor attachments that ACME Engineers have designed. They were made to meet the present day need for greater speed and durability on automatic machinery . . . they offer smoother running performance . . . greater speed resulting in higher production.

Time and time again, ACME Engineers have proven that made-to-order conveyor chain attachments need not be costly.

At ACME, special attachment costs are lowered through modified design and development. From a wide selection of standard attachments, ACME Engineers incorporate as many standard parts as possible into each special attachment produced, giving you higher productivity while lowering your initial tool costs. ACME chains are available in a complete range of sizes from 1/4" pitch to 2½" pitch.

Whatever your requirements, call your Industrial Distributor or write ACME's Engineering Department, at no cost to you, for a practical solution to your attachment problems.

Acme Chain Corporation
Holyoke
Massachusetts

RELIABLE CHAIN DRIVES FOR ALL INDUSTRIES

Write Dept. 11-P for new illustrated 106 page catalog with engineering section.

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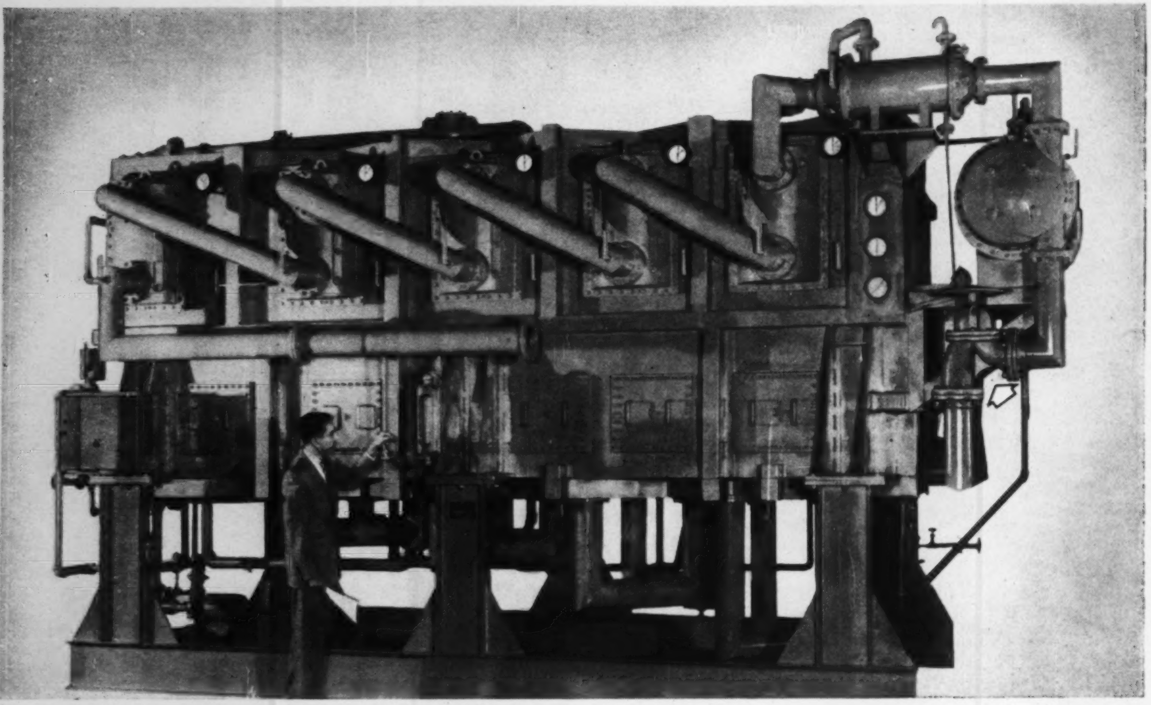


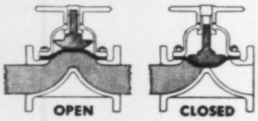
ON LAND At Salinas, a tourist center in Ecuador, this Cleaver-Brooks Flash Evaporator delivers 50,000 gallons of pure, distilled water every 24 hours. It is equipped with two 6", rubber lined, weir-type Grinnell-Saunders Diaphragm Valves — only one of which can be seen from this view.

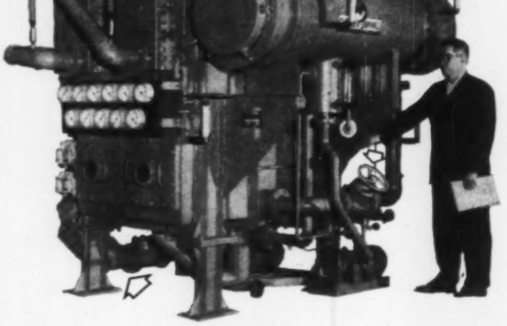
Grinnell-Saunders Diaphragm Valves help convert salt water to fresh water

You can convert sea water to fresh water, in abundant supply, on land . . . or on shipboard, with flash evaporators made by Cleaver-Brooks Special Products, Inc., Waukesha, Wisconsin. Grinnell-Saunders Diaphragm Valves are used as original equipment on these distillation units because they offer positive, leak-tight closure; flow control in throttling position; corrosion-resistance.

You'll find Grinnell-Saunders valves widely used in other fields, too . . . petroleum, papermaking, chemical, food, compressed air . . . to mention a few.

The operating principle of the Grinnell valve is the feature which makes it so adaptable. The diaphragm lifts high for streamline flow in either direction; seals tight for positive closure against grit, scale, solid matter, pressure or vacuum. Bonnet mechanism is completely isolated at all times from the fluid in the line by the diaphragm, preventing corrosion and contamination. Smooth passage, without pockets, eliminates trapping of solids and reduces frictional resistance. And you can get body, lining and diaphragm materials to meet your particular service conditions. Get *all* the facts. Write Grinnell Company, Providence 1, R. I.





AT SEA The nuclear powered NS Savannah has two 16,000 gallons-per-day Cleaver-Brooks distillation units to supply the entire water requirements of crew and machinery. Each unit has two 4" Grinnell-Saunders Straightway Valves of ductile iron.

GRINNELL

Pipe, Fittings, Valves, Hangers, Heating and Piping Supplies
Branch Warehouses and Distributors From Coast To Coast

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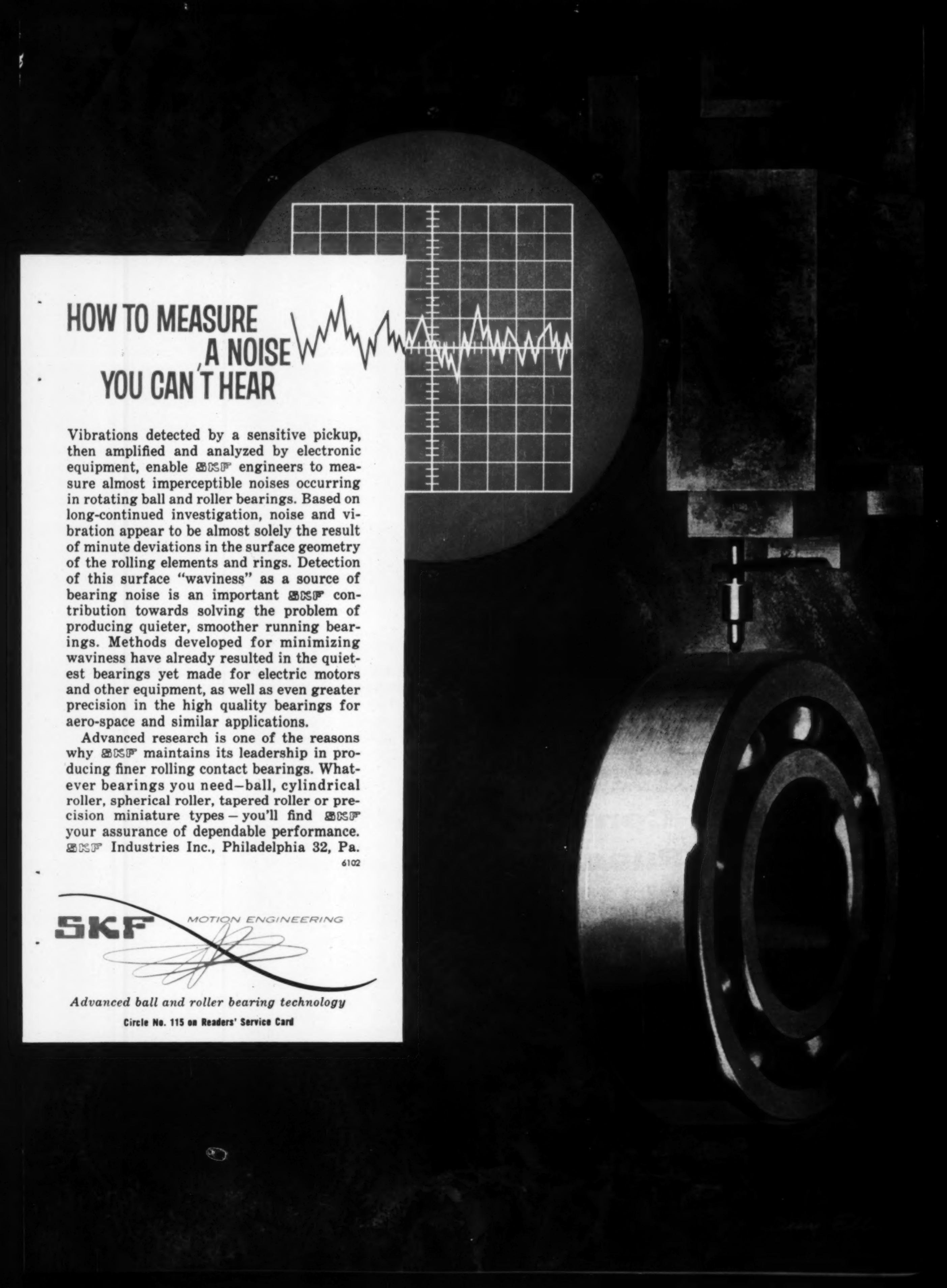

HOW TO MEASURE A NOISE YOU CAN'T HEAR

Vibrations detected by a sensitive pickup, then amplified and analyzed by electronic equipment, enable SKF engineers to measure almost imperceptible noises occurring in rotating ball and roller bearings. Based on long-continued investigation, noise and vibration appear to be almost solely the result of minute deviations in the surface geometry of the rolling elements and rings. Detection of this surface "waviness" as a source of bearing noise is an important SKF contribution towards solving the problem of producing quieter, smoother running bearings. Methods developed for minimizing waviness have already resulted in the quietest bearings yet made for electric motors and other equipment, as well as even greater precision in the high quality bearings for aero-space and similar applications.

Advanced research is one of the reasons why SKF maintains its leadership in producing finer rolling contact bearings. Whatever bearings you need—ball, cylindrical roller, spherical roller, tapered roller or precision miniature types – you'll find SKF your assurance of dependable performance. SKF Industries Inc., Philadelphia 32, Pa.

6102

SKF MOTION ENGINEERING

Advanced ball and roller bearing technology

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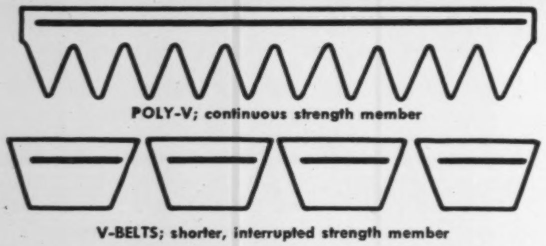
POLY-V; continuous strength member
V-BELTS; shorter, interrupted strength member

"MORE USE PER DOLLAR"

Poly-V Belt is a single unit with even, uniform pull. Uninterrupted strength member gives much higher hp capacity per inch of drive width. No belt drive delivers as much power in the same space as Poly-V!

Steel Mill Converts to R/M POLY-V BELT on Rugged Hot-Saw Drive!

A 34½" wide R/M Poly-V® Belt of 92 ribs now delivers "power plus" on this punishing hot-saw drive at one of the country's largest steel works. Converting to Poly-V eliminates the problems of a multiple V-belt drive . . . matching, stretching, overloading, whipping and snapping of individual V-belts.

The patented Raybestos-Manhattan Poly-V Drive is a single unit, V-ribbed belt design that mates perfectly with Poly-V sheave grooves, eliminates V-belt stretch and length matching problems . . . reduces costly machine downtime and production slowdowns for individual belt replacement. Sheave ratio and belt position remain constant from *no* load to *full* load . . . assure smooth, *complete* power delivery under the toughest drive conditions. Poly-V Belt can't sink in the grooves under surges of load. This means less wear on belts and sheaves . . . and much more power in the same space as a multiple belt drive—or equal power in much less space!

Just two Poly-V Belt cross-sections meet every heavy duty drive requirement. Let an R/M representative show you how Poly-V Drive can give you greater power-packed performance and drive dependability . . . "More Use per Dollar" than the drive you now use. Write for Bulletin M141.

RM1020

When You Change Drives . . . Convert to R/M Poly-V Drive and Be Sure!

RAYBESTOS-MANHATTAN, INC.
MANHATTAN RUBBER DIVISION, PASSAIC, NEW JERSEY

R/M

ENGINEERED
RUBBER
PRODUCTS
. . . MORE USE
PER DOLLAR

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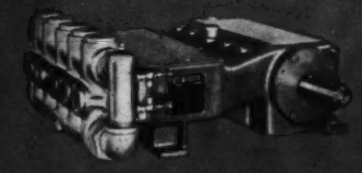
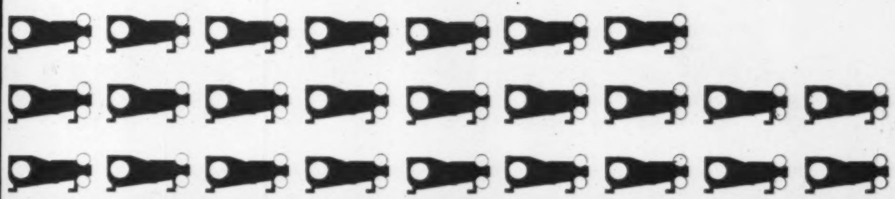
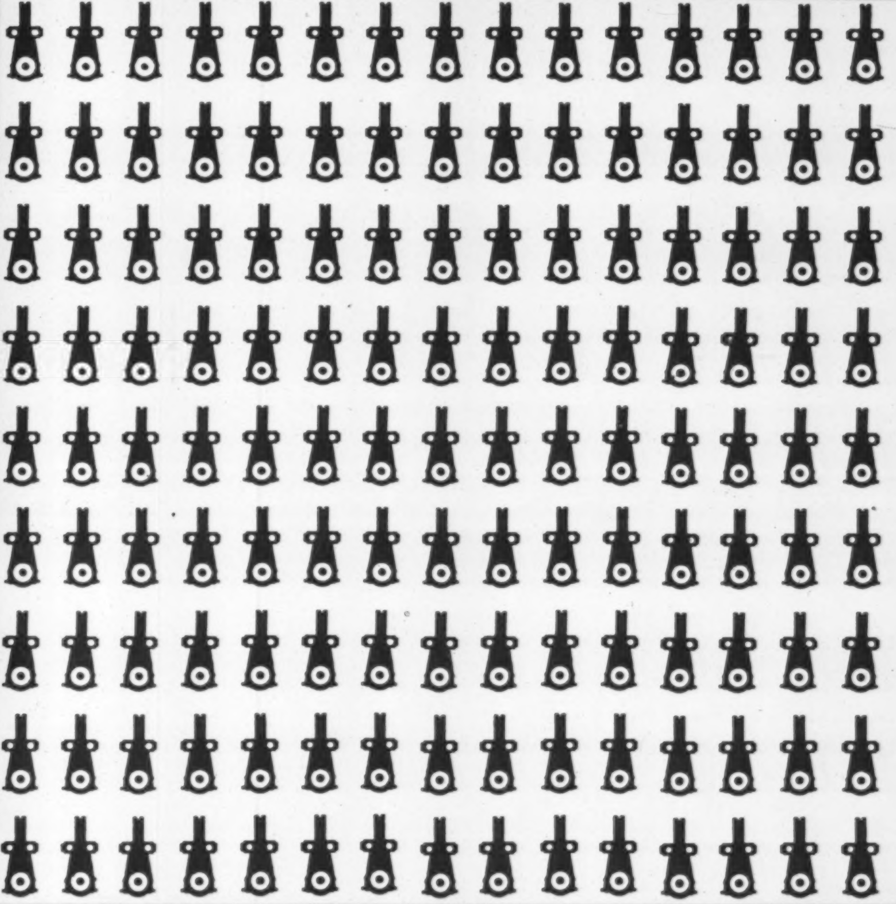


HORIZONTAL PLUNGER PUMP
25 sizes—15 to 160 HP



VERTICAL PLUNGER PUMP
135 sizes—20 to 900 HP



Choose a Worthington plunger pump . . .

ODDS FAVOR YOU—160:1

Yes, you can choose from 160 standard sizes in the basic Worthington plunger pump line—25 horizontals, 135 verticals. You get 160 chances to be right from our basic pump models. But that isn't all.

In both lines, speeds can be varied, still other plunger and cylinder sizes are available. So each type can be tailored to deliver a very exact performance.

Remember, you choose from two basic types—horizontal or vertical. Each has its basic benefit. The horizontal power pumps have extremely low first cost; the vertical power pumps are designed for extremely rugged, long-life service.

Both vertical and horizontal Worthington power pumps are engineered to give the most reliable possible performance for their type. Stainless steel valves and Colmonoy plungers are typical long-life features.

You'll find both Worthington power pump types are designed for easy maintenance. There is fast access to valves through individual valve covers—piping remains undisturbed. Each cylinder size will accept a choice of plunger diameters to suit service conditions, and other parts are interchangeable between similar models.

Yes, because of the breadth and flexibility of the line, Worthington power pumps can be matched quickly to any power pump installation.

For information, write Worthington Corporation, Dept. 32-12, Harrison, New Jersey. In Canada, Worthington (Canada) Ltd., Brantford, Ontario.

WORTHINGTON

PRODUCTS THAT WORK FOR YOUR PROFIT

Circle No. 141 on Readers' Service Card

Marsh Makes It!

If it's a pressure gauge, dial thermometer, or needle valve, Marsh makes it...makes it in every form to suit every need...makes it better in the opinion of thousands of discriminating users. Only a few key products are illustrated here, but hundreds are described in Marsh Catalogs. Ask for information covering the product or products in which you are interested.

PRESSURE GAUGES

"Mastergauge"—the world's most effective pressure gauge for extreme service.

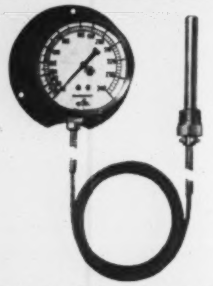
"Master-test"—"Mastergauge" quality in a gauge for services requiring high accuracy.

Quality series—second only to "Mastergauge" and "Master-test" for tough conditions.

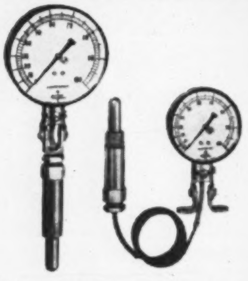
Standard series—best moderate-priced gauge for run-of-plant conditions.

DIAL THERMOMETERS

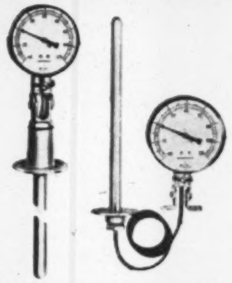
Vapor tension thermometers—direct mounted type. Many sizes; ranges.



Distant reading thermometers—vapor-tension and gas filled types in many sizes; ranges.

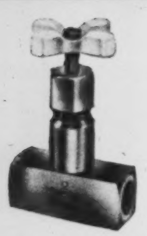


Piping thermometers—specially designed for piping. Types for all purposes, including distant reading.



Duct thermometers—specially designed for all conditions including distant reading.

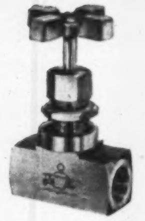
NEEDLE THROTTLING VALVES



Alloy steel—complete series of sizes and patterns. Pressures up to 10,000 psi.

416 Stainless steel—complete series of sizes and patterns in 416 stainless. Pressures up to 10,000 psi.

316 Stainless steel—complete series of sizes and patterns in 316 stainless. Pressures up to 6,000 psi.



Panel mounted—all valves—alloy steel, 416 stainless, and 316 stainless—available in panel mounted types.

MARSH

MARSH INSTRUMENT COMPANY, Dept. 29, Skokie, Ill.
Division of Colorado Oil and Gas Corporation
Marsh Instrument & Valve Co., (Canada) Ltd., 8407 103rd St., Edmonton, Alberta, Canada.
Houston Branch Plant, 1121 Rothwell St., Sect. 15, Houston, Texas.
Eastern Seaboard Warehouse: Marsh Instrument Company, 1209 Anderson Ave., Fort Lee, N.J.

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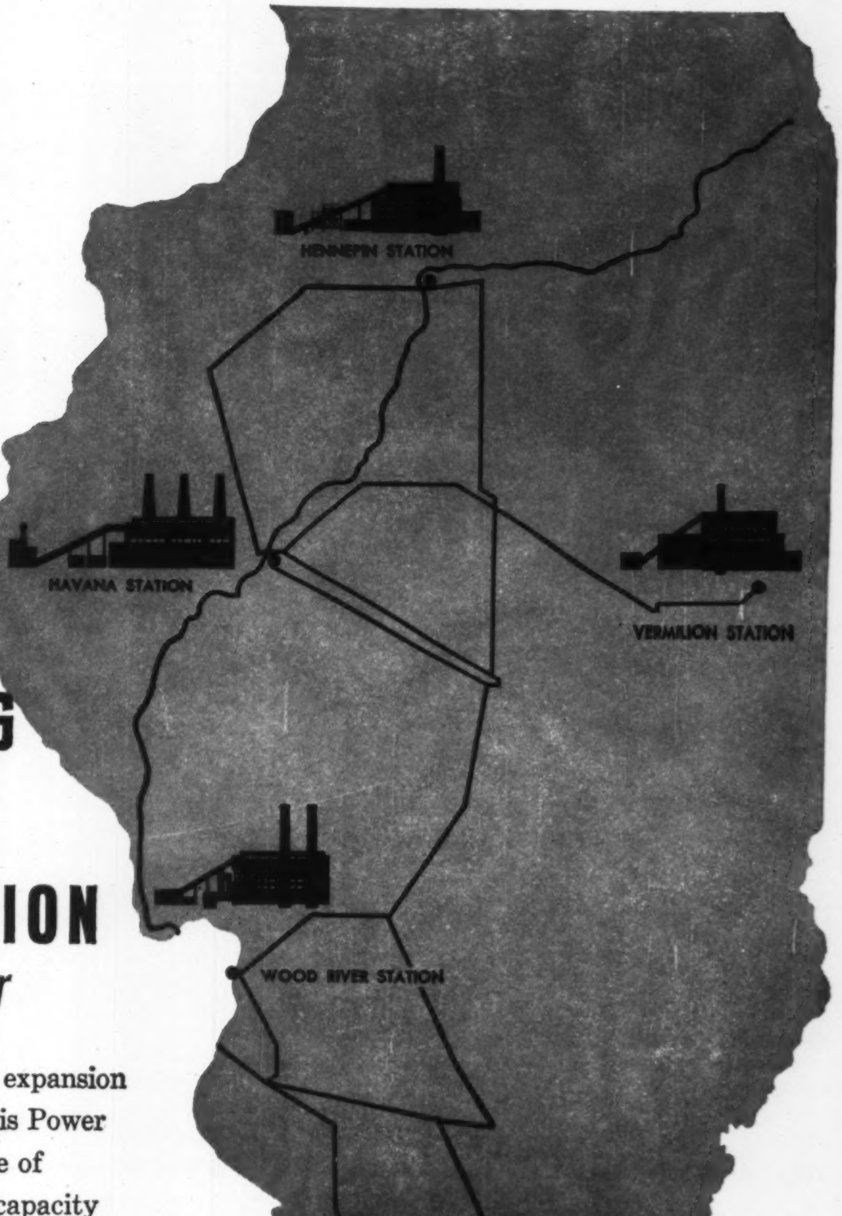

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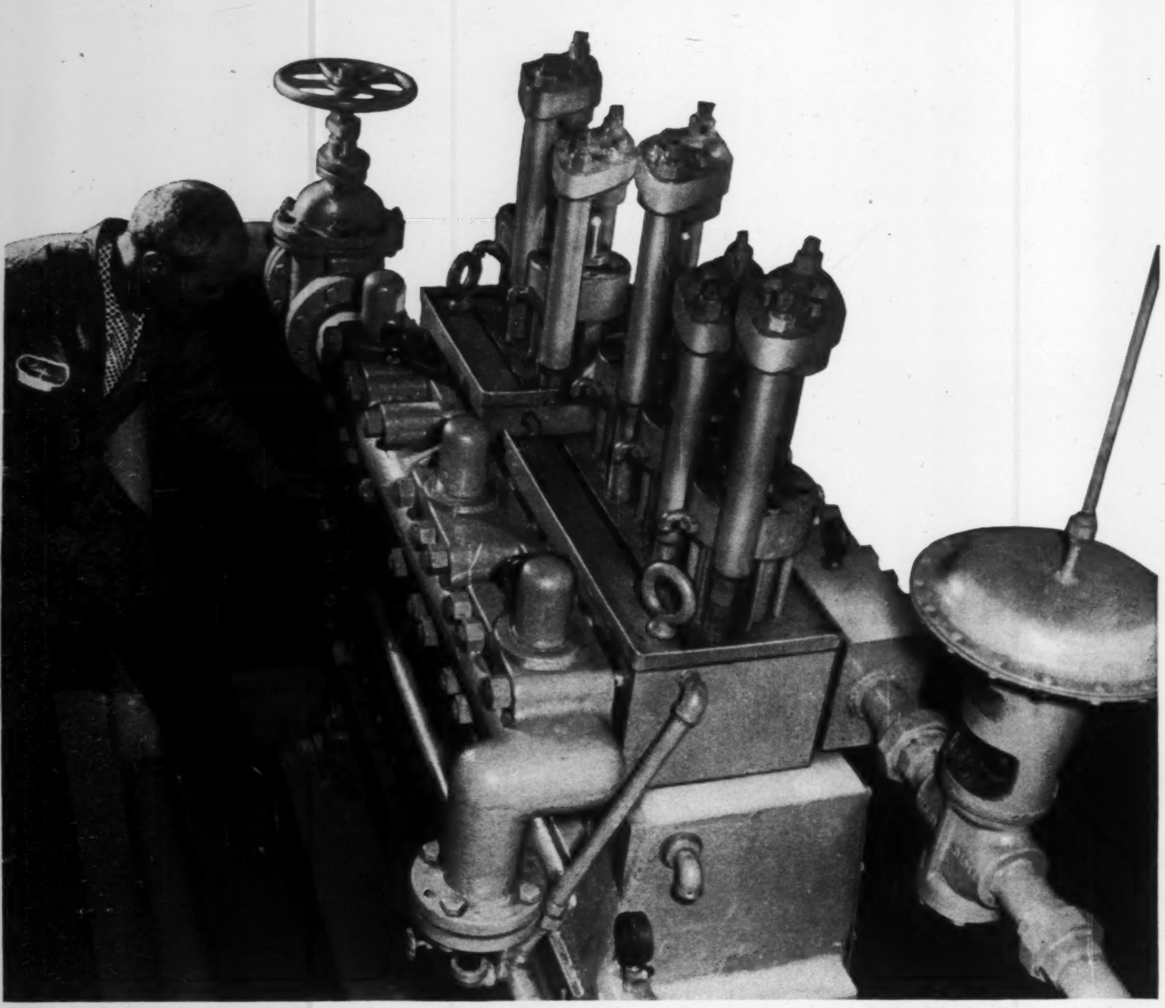

One of two Aldrich Pumps on 3-shift duty; they are quintuplex (shown) and triplex models operating at Schacht Rubber Mfg. Co., Huntington, Ind.

No easy life for this Aldrich pump

Here is an Aldrich Pump that gets no rest at all. Rubber molding and extrusion presses demand its service 24 hours a day. Pressure requirements are just as exacting . . . 170 gpm at 1200 psi must be maintained accurately, steadily. Quality of product and total productivity depend upon it. Rejects have been held to a minimum, tight delivery schedules have been met.

At the Schacht Rubber Mfg. Co., Aldrich pumps deliver water with soluble oil to presses turning out rubber houseware and hardware goods. No downtime has ever resulted. Maintenance? Routine . . . every six months. An oil check and an occasional packing replacement is all that has been required.

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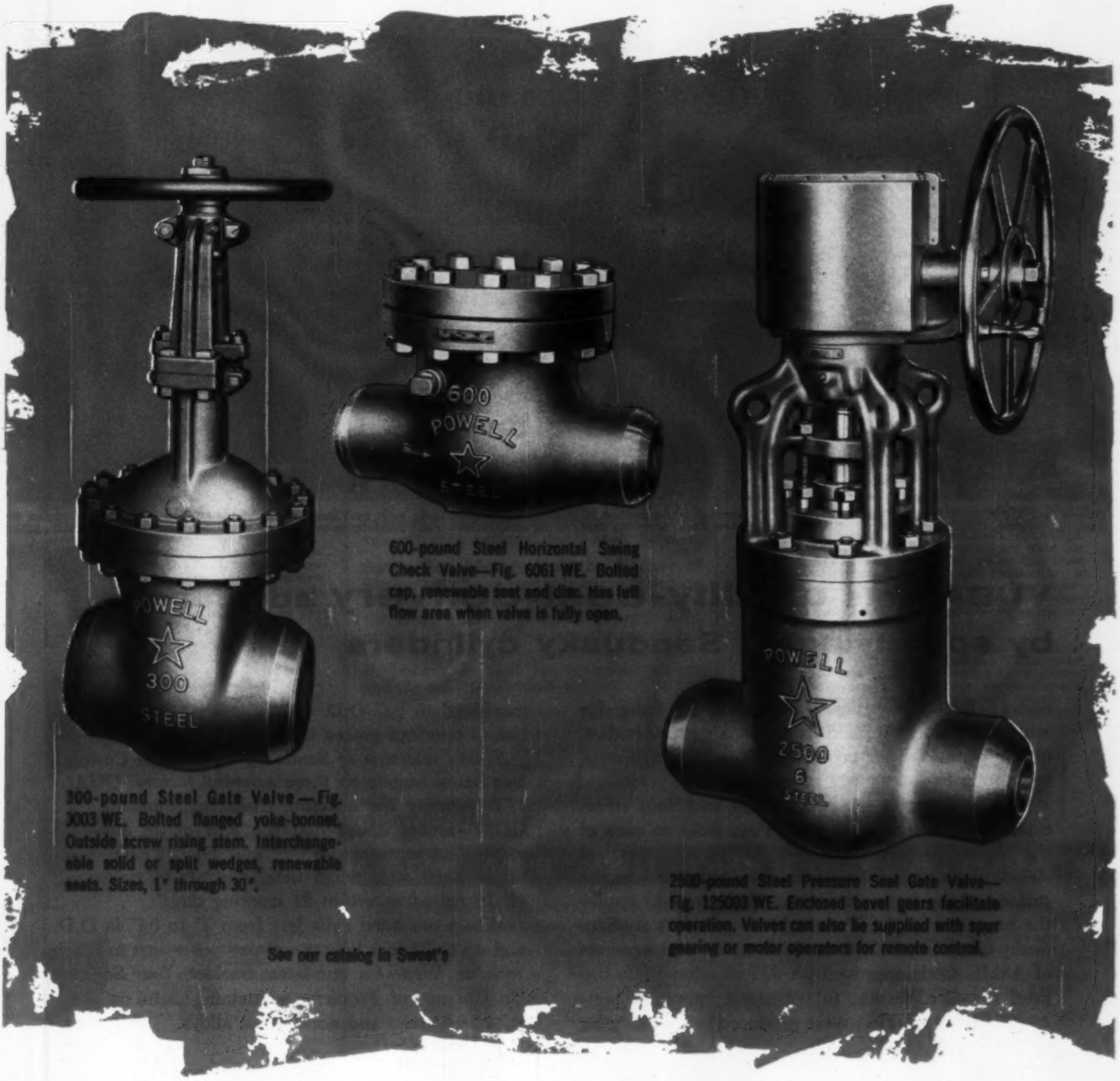

300-pound Steel Gate Valve—Fig. 3003 WE. Bolted flanged yoke-bonnet. Outside screw rising stem. Interchangeable solid or split wedges, renewable seats. Sizes, 1" through 30".

600-pound Steel Horizontal Swing Check Valve—Fig. 6061 WE. Bolted cap, renewable seat and disc. Has full flow area when valve is fully open.

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THE WM. POWELL COMPANY CINCINNATI 22, OHIO

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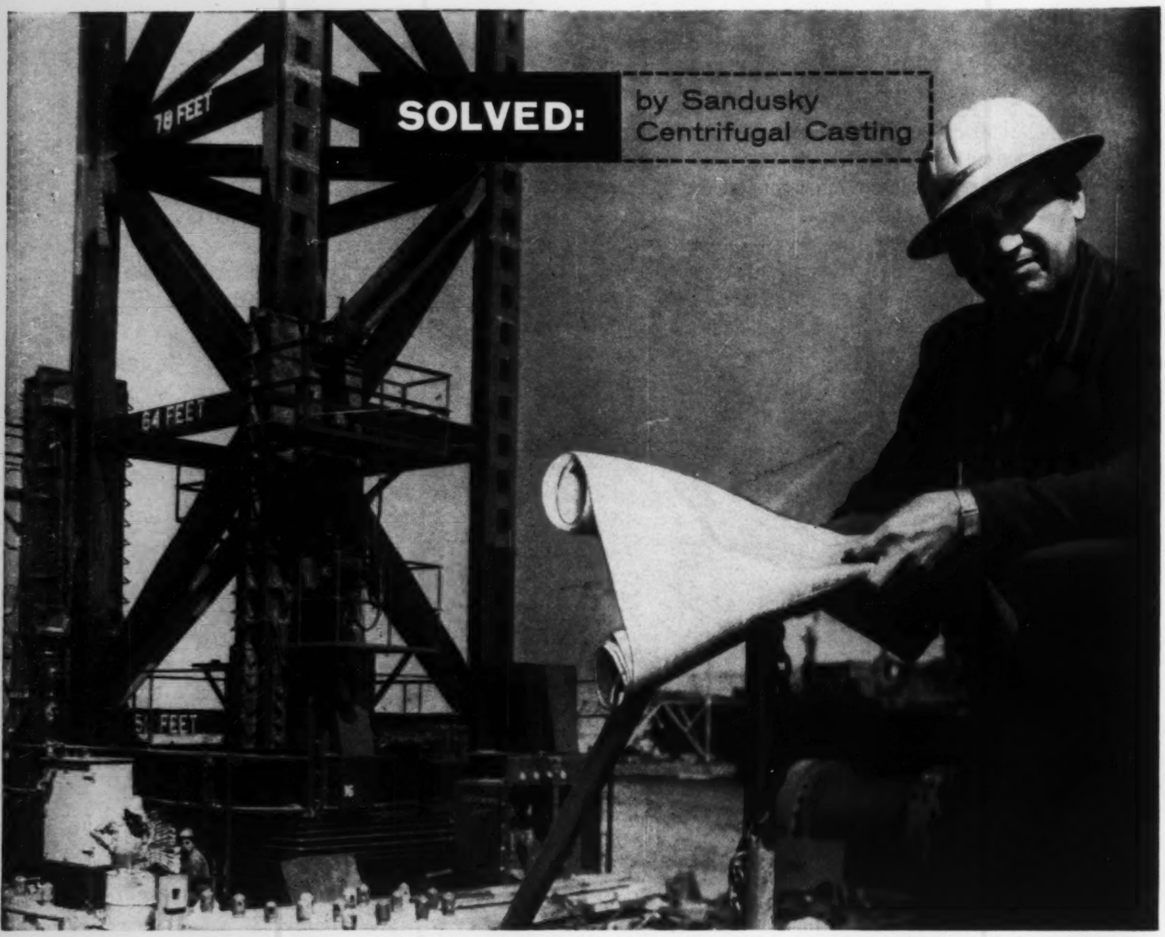

One of four 274 ft. high towers aboard the *George F. Ferris* showing method of installing hydraulic jacks built by Yuba Manufacturing Division, Yuba Consolidated Industries, Benicia, Calif. George Bauer, of Delong Corp., New York, is shown supervising construction while platform is being completed at Yuba's Richmond, Calif., plant.

YUBA gets quality-cost-delivery advantages by specifying 16 Sandusky cylinders

Sixteen 500-ton hydraulic jacks built by Yuba, for which Sandusky supplied the main cylindrical bodies, enable the new pipe-laying barge, *George F. Ferris*, to operate in waters 200 ft. deep!

This 5400-ton barge is equipped with four structural steel towers 274 ft. high. Four jacks on each of the towers provide the power to lower these steel "legs" to the ocean floor, raise the barge above the surface of the water, or retract the towers to render the barge navigable. The steel jack cylinders are Sandusky Centrifugal Castings, made to the requirements of ASME Code-approved SA-217, Section VIII, Unfired Pressure Vessels, to withstand operating pressures of 3000 psi. They were produced in 186" lengths, machined to 24" O.D. with 2" thick walls and sectioned into four pieces 43" long.

Yuba's selection of Sandusky Centrifugal Castings was based largely on three essential factors: QUALITY—meeting the exacting Code requirements . . . COST—saving about half the cost of an alternate method of manufacture . . . and DELIVERY—coming through on a tough time schedule by delivering all 16 cylinders within 21 working days!

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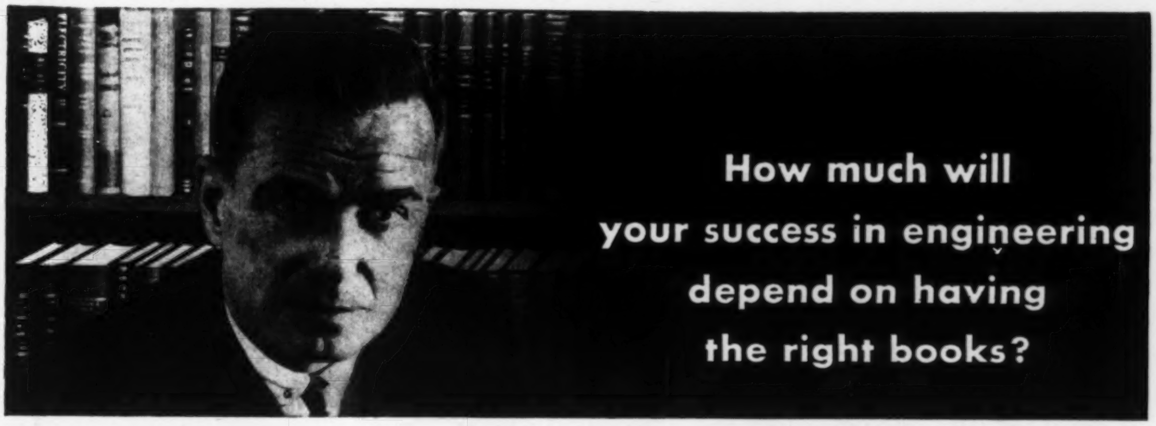

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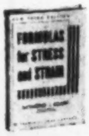

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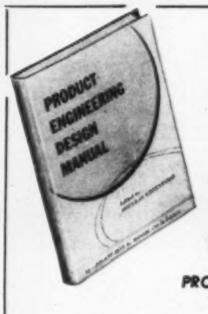

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Please contact: Mr. A. K. Newton,
Personnel Office, Atomics International,
8900 DeSoto Avenue, Canoga Park, Calif.

All qualified applicants will receive consideration for employment without regard to race, creed, color, or national origin.

ATOMICS INTERNATIONAL
DIVISION OF NORTH AMERICAN AVIATION
Circle No. 97 on Readers' Service Card

What Really Happens Inside the Bucket

Exploding a widespread misconception of the operation of inverted bucket steam traps

In describing the operation of the inverted bucket trap many well meaning people—and some not so well meaning; i.e., competitors—refer to the need for a "bucket full of steam" to close the trap, and a "bucket full of condensate" to open the trap. The implications of these requirements are many. Sometimes they are contradictory. Often they are misleading. Observations of a trap with a glass body and a glass bucket plus trap design considerations tell the true story.

* * *

In a well designed inverted bucket trap (Armstrong, naturally) the bucket will float and close the valve when it is *no more than two-thirds full of steam.* For example, the bucket in an Armstrong No. 812 trap is 3$\frac{15}{16}$" deep. It will float with only 2" of steam.

Good design also dictates that the maximum test opening pressure of a trap should be well in excess of the maximum working pressure for which the trap is furnished. For example a No. 812 trap for 100 psi with the bucket filled with cold water should open at a test pressure of at least 165 psi. Therefore, the bucket does not have to fill completely with condensate to open at 100 psi. The entrance of 1.20" of condensate will cause the bucket to sink. .8" of steam remains at the top of the bucket at the time it is heavy enough to open the valve at 100 psig and with no back pressure.

Thus the opening and closing of a 100 psi trap with 3$\frac{15}{16}$" deep bucket is controlled by a change in the water level of only 1.20".

In actual practice the 100 psi trap may be draining a steam main in which daytime pressure is only 30 psig. Instead of requiring a 1.20" rise in bucket water level to open the trap against this pressure, the bucket will be heavy enough to open the valve as soon as the water level in the bucket has risen about $\frac{3}{16}$".

Obviously, it does not "take a bucket full of steam" to close the inverted bucket trap, or a "bucket full of condensate" to open the trap.

What's the Significance?

As illustrated above the opening of an Armstrong Trap requires the accumulation in the trap of less than one-third of a bucket full of condensate. This assures good operating characteristics for the vast majority of services by discharging small accumulations of condensate as soon as they reach the trap. It also assures frequent opening pressure drops to break up air and condensate films on heat transfer surfaces and thereby maintain high heat transfer rates in the unit being drained.

Additionally, the fact that no more than two-thirds of a bucket of steam is required to float the bucket means that there will always be a generous water seal at the bottom of the bucket. In the case of the No. 812 trap described above, it will be 1.8" deep. This insures that no steam can leak from the bottom of the bucket. More importantly, the bucket can float to close the valve even when the bucket is not completely submerged in condensate.

A Proven Principle Engineered Up to the Minute

While the inverted bucket concept for steam traps is half a century old, today's Armstrong inverted bucket traps incorporate design considerations unknown 50 years ago. The inverted bucket of the Armstrong trap, for example, is not just an upside down bucket. It is a carefully sized, weighted and vented component of a steam trap mechanism that experience proves will do its job right. Throughout, Armstrong design has kept pace with technological advancements, modified when necessary to meet changing requirements.

We do not claim that Armstrong Traps will do every single job better than any other trap. But we do believe it will do more jobs better and more consistently than any other trap. More important, though, for most services, Armstrong Inverted Bucket Steam Traps enable you to get more efficient steam utilization with minimum problems.

We're so sure of what Armstrong Traps can do that we unconditionally guarantee that they will satisfy you. You are the sole judge, too, so there's practically no risk.

* * *

The 48 page Armstrong Steam Trap Book describes other Armstrong features. It also discusses trap selection, installation and maintenance. Ask your Armstrong Representative for a copy or write: **Armstrong Machine Works, 8942 Maple Street, Three Rivers, Michigan.**

ARMSTRONG STEAM TRAPS

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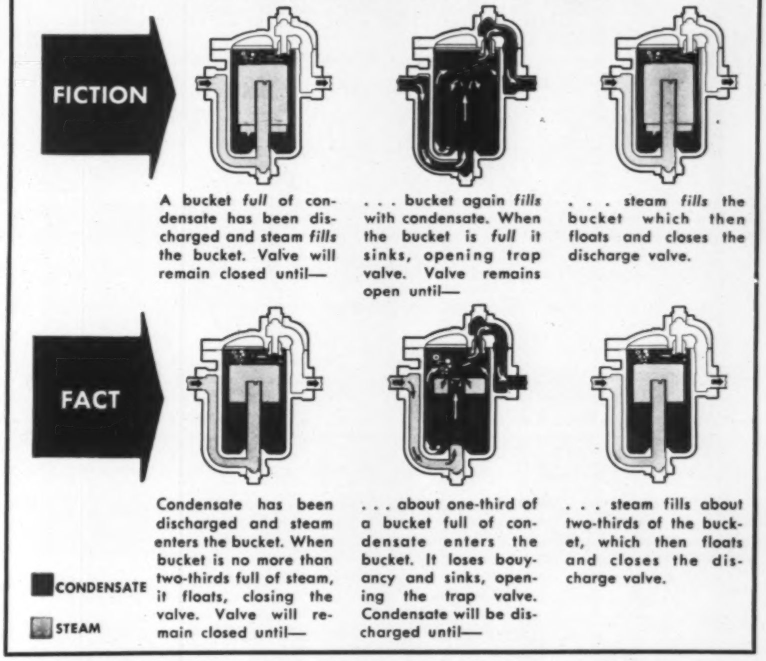
HOW THE INVERTED BUCKET TRAP WORKS



A bucket *full* of condensate has been discharged and steam *fills* the bucket. Valve will remain closed until—

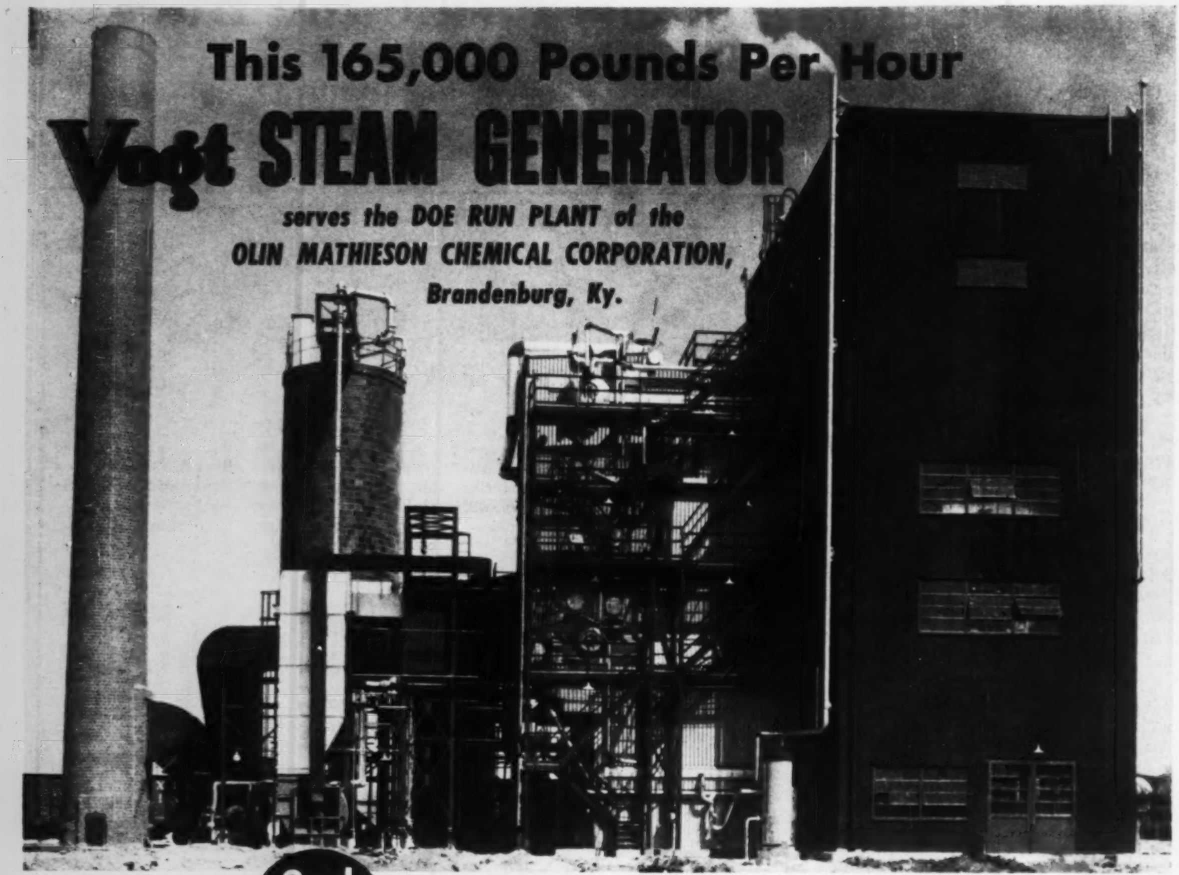
. . . bucket again *fills* with condensate. When the bucket is *full* it sinks, opening trap valve. Valve remains open until—

. . . steam *fills* the bucket which then floats and closes the discharge valve.

Condensate has been discharged and steam enters the bucket. When bucket is no more than two-thirds full of steam, it floats, closing the valve. Valve will remain closed until—

. . . about one-third of a bucket full of condensate enters the bucket. It loses bouyancy and sinks, opening the trap valve. Condensate will be discharged until—

. . . steam fills about two-thirds of the bucket, which then floats and closes the discharge valve.



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Vogt STEAM GENERATOR

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OLIN MATHIESON CHEMICAL CORPORATION,
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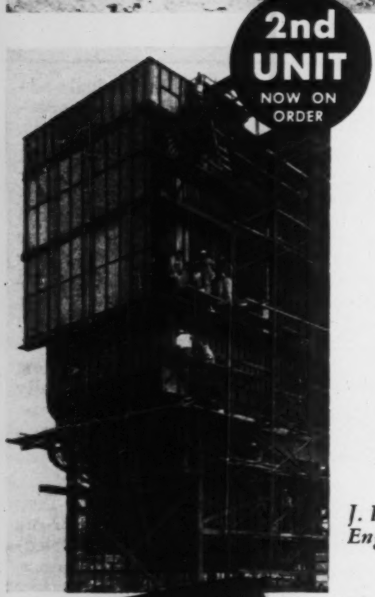

Installed out-in-the-open, the unit generates 165,000 pounds of steam per hour at an operating pressure of 650 psig and 750°F. total temperature when firing pulverized coal or gas in a tangent tube, fully water cooled, pressure tight, steel encased setting.

Outdoor installations, with firing equipment housed, have been promoted by Vogt for many years. They help reduce building and operating costs in leading chemical plants and refineries across the nation.
Contact the Vogt representative nearest you before purchasing new steam generating equipment.

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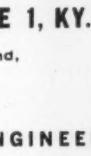

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MECHANICAL
ENGINEERING

VOLUME 83 • NUMBER 10 • OCTOBER 1961

A New Home

Editor, J. J. JAKLITSCH, JR.

Over the Labor Day weekend, ASME plus 18 other engineering societies and organizations moved into a new home on United Nations Plaza: The United Engineering Center, 345 East 47th Street, New York, N. Y. (See the ASME News for further details.) And, as would be the case, the difficulties and confusion of moving came just at the deadline dates for Mechanical Engineering and on top of preparation of preprints for the 1961 ASME Winter Annual Meeting. So if something goes wrong on the pages of this issue the editors will be annoyed but not necessarily astonished.

While any move has its inconveniences, moving to a new air-conditioned building has its advantages: Better working conditions, new scenery—in this case a panoramic view of the East River and the United Nations aggregate. The familiar dingy walls have been replaced by unfamiliar ones, clean and modern. A different arrangement of desks and persons also creates a new atmosphere.

It is to be hoped that this new environment will inspire its inhabitants to better work, greater accomplishments. But it has been said that the inspiration for better work is not derived from external environment. Its strength and vitality come from within.

In the new Center ASME's staff of 140 occupies the 5th, 6th, and 7th floors. Consisting of 20 stories, the slim tower of glass, stainless steel, and limestone was constructed at a cost of more than $12,000,000. It is a credit to engineers everywhere that a substantial portion of this cost was met by contributions from members of the occupying Societies, from individuals who are not members but are appreciative of the importance of the Center, and also in considerable sum by industry.

This enthusiastic participation in the Building Fund Campaign of so many donors (nearly one half of the ASME membership contributed) has been a gratifying expression of the universal realization of engineering's momentous role in improving the standards of living and in providing indispensable and vital services in peace and war.

Thus, after some 55 years, the Engineering Societies Building on West 39th Street closes its doors. Opening its doors is a new, sparkling, up-to-the-minute structure that testifies to the best in engineering.

The United Engineering Center will serve as a symbol and as an operating headquarters. The design and setting will bear witness to the ideals, stability, and prestige of engineers.

As headquarters for the engineering profession, it will improve service to members, particularly those who give their time to the work of boards and committees, and facilitate co-operation among societies.

Through the Engineering Societies Library, said to be the world's largest, the Center will enable engineers throughout the world to make use of the collected literature of the profession.

The operation and use of the new United Engineering Center will advance the creative influence of engineers on civilization. It will emphasize the basic unity of the many special engineering fields, reveal to laymen the constructive forces which the engineer controls as a public trust, and dramatize the engineer's concept of international professional responsibility. And, most important, the center will reflect the integrity and spiritual values which guide engineers and enrich their services to mankind.—*J. J. Jaklitsch, Jr.*

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The author's view of the future is startling, but altogether attractive. With the new productivity—made possible by production engineers—we shall use leisure as any other resource, wisely and thoroughly.

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PRODUCTIVITY IN THE FUTURE

By W. F. S. Woodford,

Secretary, The Institution of Production Engineers,
London, England

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This is addressed to production engineers, with particular regard to international co-operation in the future.

How far away is the future? I propose to set my limit at the year 2000 A.D. and to regard the future as being the next 40 years.

As world population grows, the sheer weight and volume of demand for the goods and services of civilization will compel politicians to pay greater attention to the proper development and exploitation of the world's production resources. To do this, they must turn more and more for information and guidance to production engineers. It thus becomes apparent that production engineers must take a much wider view of their professional life and responsibilities than they have tended to do in the past.

World population today is said to be somewhere between 2000 and 2500 millions. About one half are peasants. They are poor people scratching a living from the soil and making virtually no demands upon the products of civilization; i.e., the manufactured goods for which production engineers are responsible. Thus the total production resources of the whole world are catering for the everyday needs of a little more than 1000 million people.

But, by the year 2000 A.D., we are told that there will be 5000 million people. Furthermore, none of them will be peasants, for we are not allowing civilization to grow in its own sweet way; the most advanced and most powerful nations have set themselves a deliberate policy of forcing civilization on the backward countries. It is a race between East and West as to who can get in first.

Multiply Production by 5

What does this mean in terms of production engineering? If nothing else, it means that our production resources must be increased during the next 40 years by a factor of 5. We are accustomed to living in an expanding economy; we think an annual expansion of $2^1/_2$ per cent is satisfactory, 5 per cent good, 10 per cent exceptional but, during the next 40 years, we must achieve a world economic expansion of at least 500 per cent.

There is plenty of evidence that the human mind is more than capable of encompassing such an expansion. Of all the scientists, engineers, and technologists there

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Contributed by the Production Engineering Division and presented at the Production Engineering Conference, Toronto, Canada, May 10–12, 1961, of The American Society of Mechanical Engineers. Condensed from Paper No. 61—Prod-18.

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have ever been in the history of the human race, 75 per cent or them are alive and working today. Our rate of scientific and technological advance is such that, by the year 2000, what we now consider to be miraculous will then seem as commonplace as boiling a kettle of water.

How can production engineers apply all this new knowledge to developing our production resources to cater for the daily demands of 5000 million people in 40 years time? We must obviously move at high speed into an age of truly automatic production. We must invent and apply automatic systems which at the moment seem wholly impossible.

A number of new words have crept into our vocabulary of recent years—cybernetics, ergonomics, and so on. To many practical production engineers, these terms seem no more than the mystic jargon of long-haired eccentrics. (Oddly enough, some of my friends, who actually understand these terms, who are working in the fields of study in which they are understood, and who know what they are doing, do really have long hair and are, indeed, eccentric.) But I suggest to you that, before very long, these terms, or the sciences which they represent, will become the everyday tools of production engineers.

Already there are signs of this taking place. The term "control engineering" is gaining currency and it is apparent that control engineering is taken to mean the study of automatic systems and their application to production processes.

The Cybernetic Plant

We must build fully cybernetic plants; that is, whole factories with built-in control systems, with error-detection and correction taking place without interruption of the production flow. We must at the same time devise entirely new production processes and methods. Some of my machine-tool friends regard me as a dangerous heretic when I say that the cutting of metals as a mass-production process may well be coming to the end of its useful life. Of course, metal cutting will be with us for a long time yet. Nevertheless, other materials will replace metals in many applications and the cutting of metals will eventually become mainly a development and research process. Don't ask me how we shall shape metals; I am not one of those 75 per cent of the world's supply of technologists all busy today. I am merely a layman observing the trends.

There must be no petty obstructions to the application of new mass-production processes. Our technologists, and even technicians, must be kept moving around the world learning from their colleagues and passing on their own learning. We must be prepared to launch vast schemes of capital investment in underdeveloped countries so that production can take place as near as possible to the point of consumption.

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Improved Teaching Techniques

The second field in which I believe international co-operation for productivity will be most fruitful, is in education. Educational productivity must itself be improved, in keeping with the speed of advance in other directions. Educators must themselves learn how to impart to their students more knowledge in less time.

They will have to revise their teaching methods, for they are faced with a very real problem, especially in the field of science and technology. They know that what they are teaching their students today is likely to be old-fashioned in five years and completely outmoded in ten. While teaching all that they know themselves, they must be conditioning their students' minds for the acceptance of rapid change.

We must make a gigantic international effort to spread improved techniques of teaching throughout the world. Civilization cannot be sustained if the bulk of the 5000 million people in the year 2000 are only partly literate and partly educated.

Pooling Our Knowledge

Mankind has benefited enormously from the tradition among scientists that new scientific knowledge is available freely.[1] This intercommunication between scientific workers has been severely restricted during the past 50 years, in the interests of national defense. Many of the world's most advanced scientists are working under an impenetrable cloud of governmental secrecy.

Much of today's scientific efforts are directed to specific purposes, for example, shooting fireworks at the moon. From these efforts, there is a massive spillover into industry of new scientific and technological knowledge. There is an urgent need for a great expansion of industrial research and development to exploit this new knowledge and adapt it to production requirements.

Here is another field for fruitful co-operation at the international level. There is ample scope for international agreement on areas of industrial research and development. It is obviously ridiculous for us all to be doing the same thing at the same time. The days of the "trade secret" mentality are over; events are moving too fast. Production engineers, because of their professional training in the field of organization and management, are especially well equipped to establish organizational patterns which will allow this co-operation to flourish.

1996
1997
1998
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2000

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[1] Ed. Note: It has been observed that the forward sweep of modern engineering dates from the beginning of the great engineering societies such as ASME.

1996
1997
1998
199
PRODUCTIVITY
IN THE FUTURE

Co-operation can only take place between people; between living human beings. Furthermore, it must be "willed"—it does not just happen. It is brought about only by planned positive action and the desire of all parties concerned.

The Dignity of Labor?

The effective utilization of labor offers another area where spectacular results can follow from international co-operation. There are still far too many people who believe that improved productivity can only come from people working harder—especially when the harder work is done by the other fellow. This is absolute rubbish. There can be no real advance unless we make it possible for everyone to work less hard. People talk of the dignity of human labor—just an excuse to keep the other fellow working. Those countries with the highest standard of living are the ones most highly mechanized.

In studying the proper utilization of labor, we are serving the highest purposes. For the first time in history, we have it within our reach to free mankind from economic slavery. I do not use this term in any ideological or political sense. I mean simply, that since the dawn of history, man has had to spend the greater part of his waking hours working for his sustenance and self-preservation. What is the purpose of improving productivity, of scientific advancement, of the mastery of the forces of nature, if we still have to go on working all day and every day all the year round?

In spite of all apparent advances, mankind is still working for the machine. It is high time that the machine began to work for man. I believe that engineers, and in particular production engineers, are in a unique position to confer great benefits on mankind by making it possible for men to have the time to do the things that they wish to do.

A complete reorganization of our working patterns, of the order of our social life, is highly desirable. Indeed, I believe it to be inevitable. To bring this about, however, will call for some basic rethinking on the part of employers' federations and labor unions. Time-honored practices that have been invested with the force of religious beliefs will have to go overboard. There will be no room for shibboleths in the years ahead.

Today, the 40-hr week is widely accepted in the most advanced nations; in some places already there is talk of a 30-hr week. I should like to suggest a completely fresh approach to this question of working hours.

When the whole world population is educated to a level beyond the mere ability to read and write, people will begin to demand not only more leisure but more usable leisure. If a man has to travel to work for 5 or 6 days out of every week for 49 or 50 weeks in every year, he doesn't get much real benefit from a marginal reduction in the number of hours in any week.

Suppose, however, that we changed the unit; instead of talking of a 30-hr week, why not a 60-hr week and then a week's holiday? Fifty years ago, men worked a 60-hr week every week, all the year round, with no holidays. Let us go a step further; instead of a 60-hr week let us do 120 hr a fortnight and then have two weeks' holiday. Indeed, it would be no very great hardship to work a whole month without a break and then have a month's holiday. It is easily within our capabilities so to organize our lives that it will be possible for everyone to work a whole year without a break and then have a whole year's holiday. Think what enormous possibilities this prospect offers! Wouldn't it be worth while working for a whole year if it could be followed by a whole year of holiday—on full pay, of course?

The Use of Leisure

I am heartily sick of people who say that one of the major problems of society today is the effective use of leisure. The real problem is that people do not have enough leisure to use effectively. It is an insult to the intelligence of an educated human being to say that he is incapable of using his leisure properly. Again, it is always the other fellow. Of course, *you* know how to use *your* leisure. Give *you* a year's holiday on full pay and you will find plenty to do. But the other fellow? He'll spend his time looking at TV or playing the horses.

How much more rapidly could we achieve understanding between different people in the world if there were only time to travel freely and meet each other? How far can one usefully get in two or three weeks' annual leave? No one is going to face the expense of flying from, say, Europe to Australia if, after a few days, he has to turn around and come back again. But, given the prospect of going to Australia or Timbuctoo, or any other place, for a whole year, there are many people who would willingly meet the expense.

The very large numbers of people who would additionally be traveling would enable us to achieve substantial reductions in the cost of travel. We should be building airplanes (or hovercraft?) on the same scale that we now build cars. Think, too, of the great expansion of cultural life that could take place if only people had enough useful leisure time.

At the moment we are not free agents. We must work during most of our waking time; this is what I mean by "economic slavery." There are some people—indeed, many people—who enjoy their work, but there are vast numbers more for whom going to work is a necessary but tiresome chore. In the press-button future, occupational boredom will be more and more evident. All the more reason, therefore, to provide for long periods of freedom.

The Dominant Technology

I am well aware that in talking of international co-operation, one is all the time treading on the heels of politicians and statesmen. I believe this is a good thing. The more that engineers can influence politicians, the better. I am absolutely convinced that, within the next two or three decades, production engineering will become the dominant technology throughout the world. Spacemen, nuclear scientists, and others may still be the glamour boys but, in terms of numbers and weight of influence, production engineers must predominate.

Acknowledgments

I acknowledge the valuable assistance in the preparation of this paper which I have received from Mr. Edwin Fletcher, formerly Deputy Director of the European Productivity Association; Sir Charles Norris and Mr. E. A. Runacres of the British Productivity Council; and from my colleagues at the headquarters of the Institution of Production Engineers.

By **Alexander Zeitlin,** Mem. ASME
President, Engineering Supervision Company,
New York, N. Y.

EQUIPMENT FOR ULTRAHIGH PRESSURES

Ultrahigh pressure may be used to promote transformation and reaction, and thus act as a "universal catalyst" for production of new materials. The application to metallurgy offers possibilities.

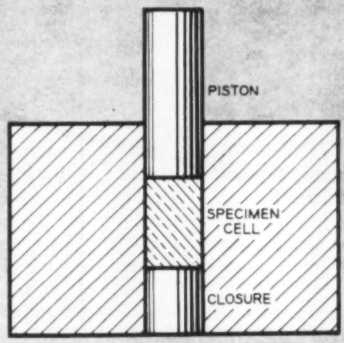

PISTON
SPECIMEN CELL
CLOSURE

Fig. 1 The most obvious method of generating high pressures is a simple hydraulically operated piston which advances within a cylinder, compressing the substance enclosed. Pressure limits are well below 50,000 psi for a thin-wall cylinder and 80,000 to 100,000 psi for a thick-wall steel cylinder operating in the elastic range.

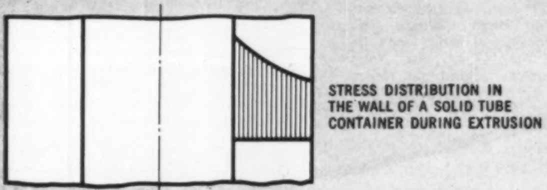
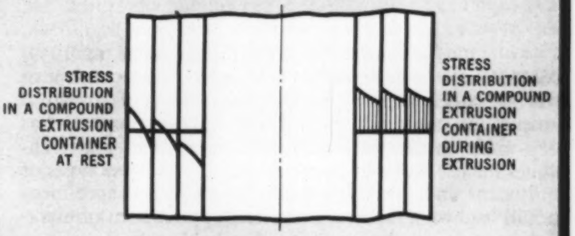
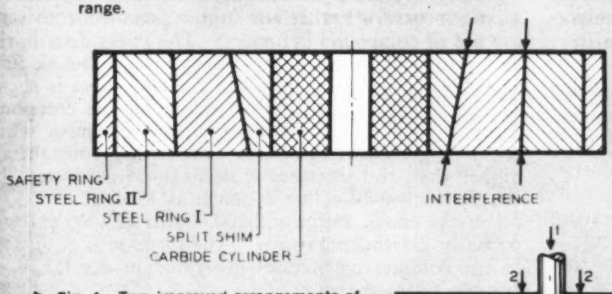
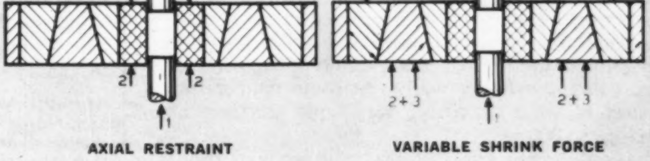

STRESS DISTRIBUTION IN THE WALL OF A SOLID TUBE CONTAINER DURING EXTRUSION

Fig. 2 Compound cylinders of more than one layer permit substantially higher pressures to be generated since only the inner layer of a thick-wall cylinder, close to the ID, is fully utilized from the viewpoint of stress. Pressures range to 150,000 to 175,000 psi and as high as 200,000 to 250,000 psi if partially plastic conditions are permissible.


STRESS DISTRIBUTION IN A COMPOUND EXTRUSION CONTAINER AT REST
STRESS DISTRIBUTION IN A COMPOUND EXTRUSION CONTAINER DURING EXTRUSION


SAFETY RING
STEEL RING II
STEEL RING I
SPLIT SHIM
CARBIDE CYLINDER
INTERFERENCE

◀ **Fig. 3** Compound cylinders utilizing tungsten carbide expand the range substantially. There are three basic rings in a design by H. T. Hall—an inner tungsten-carbide ring and two steel rings. Repetitive pressures up to 500,000 psi or a few cycles at 750,000 psi are possible.


1
2
2
2
2
1
AXIAL RESTRAINT
1
2
2
3
3
2+3
2+3
1
VARIABLE SHRINK FORCE

▶ **Fig. 4** Two improved arrangements of compound cylinders provide axial restraint and an increase in the shrink force between the carbide and the two steel cylinders in proportion with the increase in ram pressure. Although these arrangements work well when pressure is being increased, operation is not as satisfactory during pressure release.

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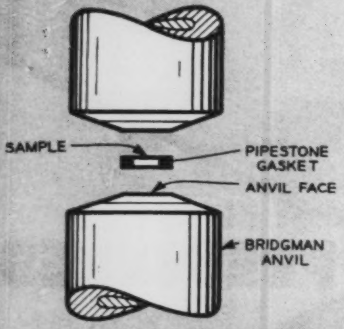

Fig. 5 A different approach is the Bridgman anvil. There are two anvils with small faces from which the material spreads sideways rather fast, limiting the area of high stresses to a small portion of the anvil. The wafer-shaped sample is surrounded by a restraining gasket of solid material which becomes viscous under pressure. Compound anvil configurations with shrink rings increase the range of pressures which can be developed. Pressures up to 3,750,000 psi are generated, and there are some claims of 7,500,000 psi.

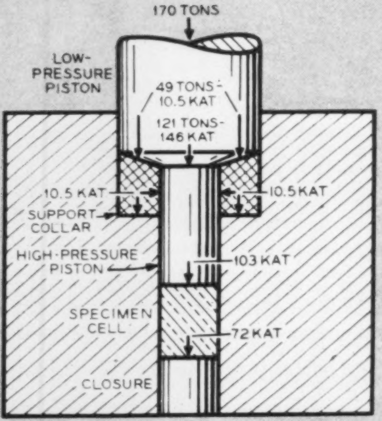

Fig. 6 The massive-support and plasticized-gasket principles have also been applied to piston-cylinder systems. The tip of the low-pressure piston provides the area of massive support while the support collar, acting as the plasticized gasket, provides radially arranged restraining force around the upper portion of the high-pressure piston. Either piston life can be extended when working around 500,000 psi or the pressure range can be extended upward with shorter life. Pressure data on the diagram are in kiloatmospheres (KAT—for this purpose, roughly equal to kilobars). Pressure at the upper surface of the specimen is 1,500,000 psi. It is approximately 1,100,000 psi at the lower

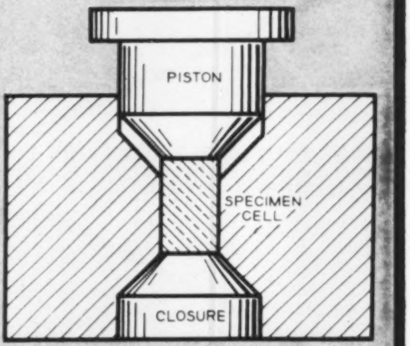

Fig. 7 The massive-support principle can also be extended to the lower closure, and the space between the upper piston and the main cylinder block filled out with an appropriate gasket material

EQUIPMENT FOR ULTRAHIGH PRESSURES

At the time of his retirement in 1959, Nobel Prize winner Percy W. Bridgman was the author of over 300 papers and two books on the effects of ultrahigh pressure on matter.[1] Since then, further progress has been made in the development of equipment and techniques for the work he began in 1909. The new types of equipment and greatly increased sizes of test specimens should lead to many new industrial applications of ultra-high-pressure techniques in the fields of chemistry, metallurgy, and related areas.

Some of the general-purpose equipment available for basic and applied research as well as for production applications will be reviewed. Specialized equipment for such fields as x-ray and optical work will be omitted.

Generating High Pressures

Simple Cylinder. The most obvious method of generating high pressures is a hydraulically operated piston, Fig. 1. The maximum pressures obtainable in the cavity of this type of apparatus depend upon the strength of the materials used and the stresses developed in the cylinder and piston. The pressures generated within a thin-walled cylinder are limited to a fraction of the permissible stress in the cylinder wall. At room temperature, with steel of some ductility, obtainable pressures are well below 50,000 psi.

Increasing the thickness of the cylinder wall results only in a limited increase of the pressures that can be contained since only the inner layer of a thick-wall cylinder close to the ID is fully used from the viewpoint of stress. The greater the removal from the cylinder axis, the less the utilization of the stress properties of the material. It is, therefore, useless to make the OD of a thick-wall cylinder greater than 3 or 4 × the ID.

An infinitely thick cylinder will not allow pressures in excess of 0.58 of the permissible stress, limiting a thick-wall steel cylinder operating in the elastic range to pressures of about 80,000 to 100,000 psi.[2]

Compound Cylinders. The next step in the development of arrangements for higher and higher pressures consists of the use of compound cylinders. The stress distribution in a two-layer compound cylinder with a shrink fit of reasonable interference between the two tubes is shown in Fig. 2. A review of the stresses in the compound cylinder shows immediately that the pressures which could be generated in such a cylinder are substantially higher than the pressures which can be generated in a simple thick-wall tube—as much as 150,000 to 175,000 psi in the elastic range and 200,000 to 225,000 psi with partially plastic conditions. The increase is equivalent to the compressive stresses generated in the ID of the cylinder when at rest.

Substituting Other Materials. Configurations of this type can be made of alloy steel with cavity diameters of 4 to 5 in. and even larger. The introduction of stronger materials, in particular tungsten carbide, allows a further increase of generated pressures. However, the fabrication of large tungsten-carbide rings is difficult, limiting ID's to the range of 1 to 2 in.

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[1] A comprehensive Bibliography on Bridgman's publications is available on request from Engineering Supervision Company, 51 East 42nd Street, New York 17, N. Y.

[2] It must be pointed out that the quoted yield strength applies to "reasonable size" workpieces with a cavity diameter of 5 to 6 in. Larger workpieces show a substantially lower yield point and consequently the pressure state cannot be generated in thick-wall cylinders of more than 5 to 6 in. ID.

Proper arrangements of the cylinder and rams would allow exceeding the yield point in certain limited areas of the cylinder. A partially plastic thick-wall cylinder can be made to store more strain energy than a thick-wall cylinder in a purely elastic state. Allowing a plastic zone of approximately 50 per cent of the total wall thickness results in the possibility of containing pressures up to 125,000 psi. Proper care must be taken in the design to limit the length of the test cavity to a fraction of the total length of the thick-wall cylinder in order to eliminate the effect of the ends.

A simple piston-cylinder system is usable to approximately 250,000 psi. A compound cylinder, Fig. 3, of three basic rings (an inner one of tungsten carbide and two of steel) can be used for repetitive application of pressures of up to 500,000 psi (35 kilobars). Generation of higher pressures is possible, but the life of the device is rapidly reduced to a few cycles at 750,000 psi.

Improving the arrangement to provide axial restraint, Fig. 4 (top), counteracts the axial tension stresses generated in the carbide cylinders under the influence of the Poisson effect. The auxiliary pressure 2 is proportional with the ram pressure 1 so that the tension stresses due to the application of pressure 1 are counteracted by an appropriate level of pressure 2. The correlation between pressure 1 and pressure 2 can be properly controlled when pressure is being increased, but is difficult to maintain during pressure release.

At the bottom of Fig. 4, an arrangement is shown which increases the shrink force between the carbide and the two steel cylinders in proportion with the increase in ram pressure. Pressures 2 and 3 are applied to rings moving downward while the combined pressure 2 plus 3 is applied to the intermediate ring moving it upward, thus increasing the shrink fit when pressure 1 is rising. Again, this arrangement works satisfactorily to 500,000 psi. At the most, 750,000 psi is obtainable with carbide rams but useful life is reduced to a single cycle.

The Bridgman Approach

Realizing the shortcomings of all these devices, Bridgman suggested a somewhat different approach—anvils, Fig. 5. The two rams or anvils have rather small faces from which the material spreads sideways quickly so that the area of high stresses generated in the vicinity of the sample is limited to a small portion of the anvil. The sample itself is a wafer surrounded by a restraining gasket made of solid material which becomes viscous under pressure. The figure shows the anvils designed as compound configurations with the shrink rings *C* and *D* increasing the range of pressures which can be developed between the anvils *A* and *B*. Very high pressures have been generated with the help of this device. There is general agreement that pressures up to 250 kilobars (3,750,000 psi) can be generated, although the claims of individual researchers to 500 and even more kilobars (7,500,000 psi) are controversial.

Specimens processed between Bridgman anvils are small; thickness is usually about 0.010 in., and diameter usually does not exceed $^1/_8$ in., preventing use for applied engineering investigations.

Important Principles. Two features of Bridgman's anvil became of extreme importance for further development of high-pressure apparatus—the massive-support principle, and use of pressure-transmitting material which becomes viscous under pressure. Massive support reduces the area of high stresses, providing rapid diffusion of stresses into larger cross sections, thus exercising a restraining force on the anvil surface.

The gasket which becomes viscous under the influence of the pressure is reduced in thickness simultaneously with the compression of the specimen. The excess material flows outward, thus leaving the area of high pressures and solidifying outside the anvil contact area to form a solid restraining ring around the anvil tips. The restraining force exercised by the extruded gasket assists in counteracting the bursting forces which are generated tangentially to the anvil surface.

Bridgman has tested a large number of materials and has indicated a number of substances which can be used as plasticized gaskets. The most popular are pyrophyllite (common lava, which is basically an aluminum silicate), pipestone, talc, sodium chloride, and silver chloride. Even metals can be used as gasket material for pressures well above their yield point.

The massive-support and plasticized-gasket principles are applicable to piston-cylinder systems, Fig. 6. The tip of the low-pressure piston provides the area of massive support while the support collar, acting as the plasticized

EQUIPMENT FOR ULTRAHIGH PRESSURES

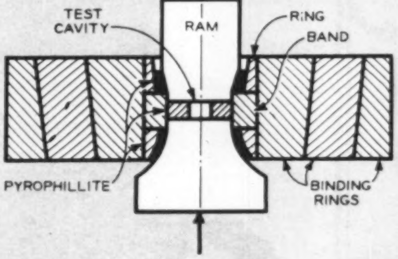


Fig. 8 The lateral-support principle has been applied to piston-cylinder systems. A tapered pyrophyllite gasket surrounds the plunger tip of the upper piston. The lower piston is flared out to increase the massive-support effect.

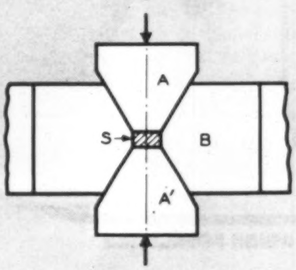


Fig. 9 H. T. Hall developed the "girdle" for G-E Research Laboratories to apply the principle of massive support not only to the ram but also to the cylinder of a piston-cylinder system

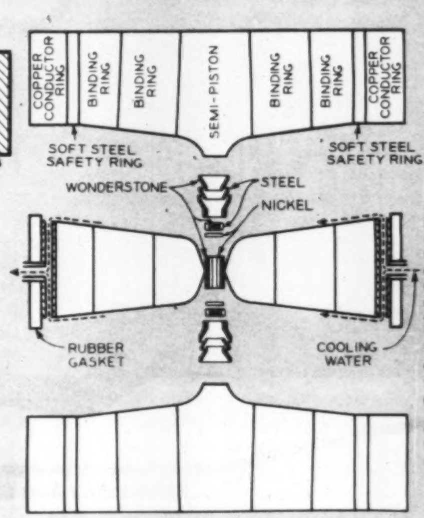
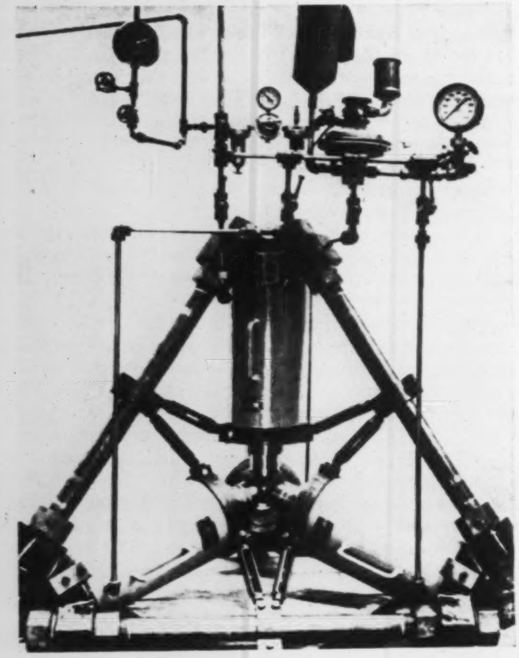


Fig. 10 The ultimate in applying massive support to both ram and cylinder is the G-E "belt" apparatus, shown exploded. Neither "girdle" nor "belt" systems overcome the scaling-up problem; thus specimens are confined to fractions of an inch.



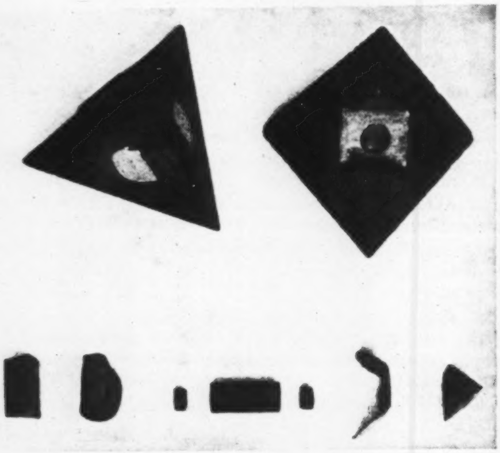
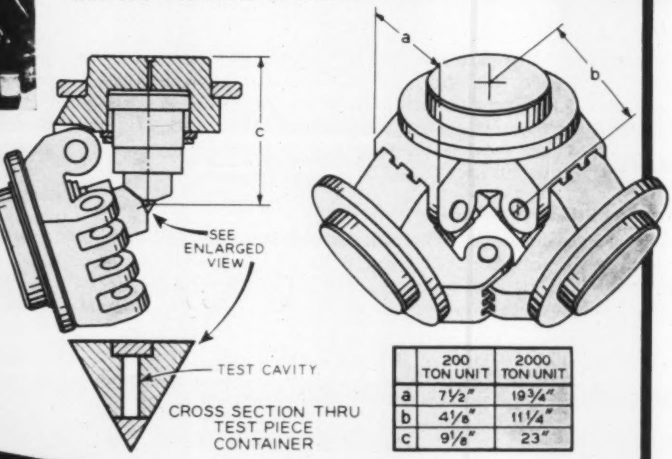


Fig. 11 Left, Concluding that it would be hopeless to attempt to scale up piston-cylinder systems, a tetrahedrally arranged ram system was developed by H. T. Hall.

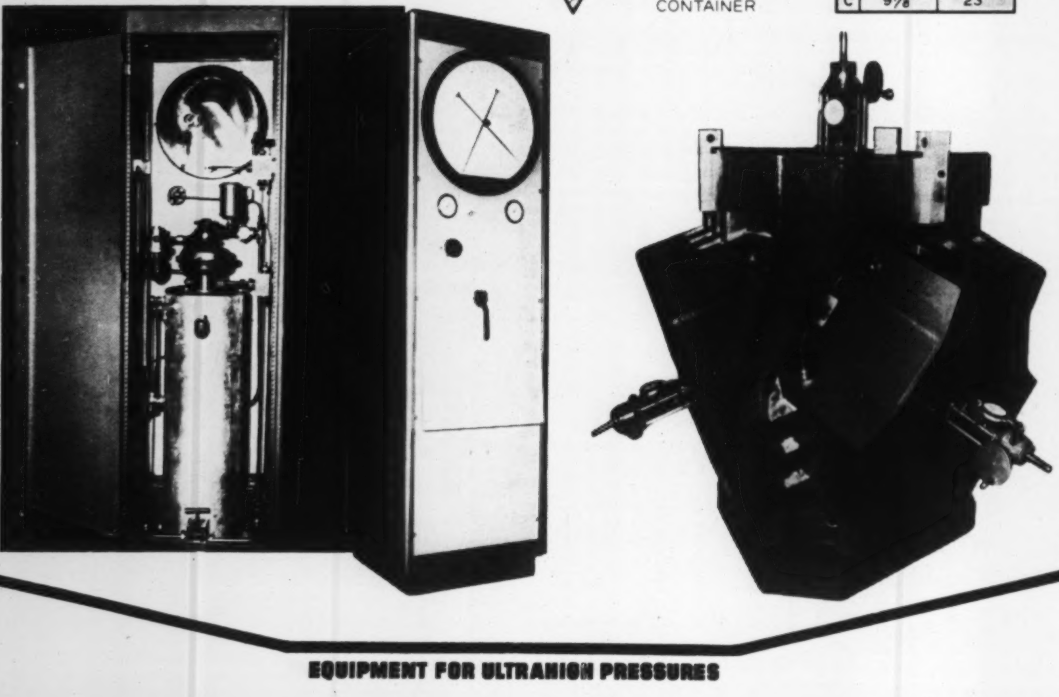
Fig. 12 Above, The original 200-ton-per-cylinder machine generated 1,500,000 psi, but the area of each face of the tetrahedron was limited to 0.33 in.

Fig. 13 Right, The tetrahedral anvil apparatus was redesigned as a hinged unit which can be scaled up. Units of 2000-ton ram capacity have been built and operated.



	200 TON UNIT	2000 TON UNIT
a	7 1/2"	19 3/4"
b	4 1/8"	11 1/4"
c	9 1/8"	23"

Fig. 14 Below, Assembly of the four heads of a 2000-ton tetrahedral hinge unit. The simple hydraulic system for the hinge unit is at the back of the control panel. With a magnification of 1 to 100, a primary pressure of 15,000 psi can be used to generate 1,500,000 psi in the test assembly.



EQUIPMENT FOR ULTRAHIGH PRESSURES

gasket, provides radially arranged restraining force around the upper portion of the high-pressure piston. If the high-pressure piston is properly lapped in within the cylindrical bore of the main block, a cylindrical support for the tip is provided by the main block proper. This arrangement improves the working conditions of the piston so that either the piston life can be extended when operating at around 35 kilobars (500,000 psi) or the pressure range can be extended upwards at the price of short piston life.

In applying the massive-support principle to the lower closure, Fig. 7, the space between the upper piston and the main cylinder block can be filled out with an appropriate gasket material. The pressure distribution in a stepped-piston arrangement shown in Fig. 6 has been published by Manufacturing Laboratories, Inc. The pressure on the large cylinder is approximately 160,000 psi. This pressure, transmitted to the plasticized gasket, generates a radial restraining force on the surface of the small cylinder in the same amount, 160,000 psi. The roughly 2,000,000 psi generated at the juncture between the large and small pistons drops rapidly due to friction so that at the upper surface of the specimen the pressure is only 1,500,000 psi, while at the lower surface of the specimen the pressure drops even further to approximately 1,100,000 psi.

As previously stated, the simple piston-cylinder systems do not have satisfactory life, and this is still further reduced when test conditions specify high temperatures within the specimen.

Piston-Cylinder-System Modifications

To obtain better performance, two-stage arrangements have been suggested, although these are intricate and further reduce the size of the already small specimen. A number of attempts have been made to improve the performance of piston-cylinder systems by modifying the configuration. In one, Fig. 8, a tapered pyrophyllite gasket surrounds the plunger tip of the upper piston. As the plunger moves down, more pressure is exerted on the gasket; increasing lateral support. The design of the lower piston goes a step further by flaring out the piston surface and thus increasing the massive-support effect. The General Electric Research Laboratories were particularly successful in this respect. The massive-support principle was also applied to the cylinder of the piston-cylinder system, and nicknamed "the girdle," Fig. 9. The ultimate in this type of development is the "belt" apparatus, Fig. 10.

Even the sophisticated "girdle" and "belt" designs do not overcome the scaling-up problems limiting specimen size to fractions of an inch.

Ram System

H. T. Hall has suggested a complete elimination of the confining cylinder and the use of a tetrahedrally arranged ram system, Figs. 11 and 12. Four massive-support anvils are located at the ends of four rams which are cylinder actuated. The original Hall machine was rated at 200 tons per cylinder. In other words, the pressure exerted by each ram on each surface of the tetrahedral cavity assembly was 400,000 psi so that in order to generate 1,500,000 psi (100 kilobars) within the test cavity, the area of each face of the tetrahedron was limited to 0.33 in.

Ram of 2000 Tons Capacity. Units of 2000-ton ram capacity have been built and operated successfully, Figs. 13 and 14. The rather simple hydraulic system in the back of the control panel is shown. The magnification obtainable in the huge apparatus is usually kept between 1 to 50 and 1 to 100 so that, for instance, with a magnification factor of 1 to 100 a primary pressure of 15,000 psi can be used to generate 1,500,000 psi (100 kilobars) in the test assembly. The extrusion of the gasket material occurs in the areas between the anvil tips so that each anvil tip is surrounded by the extruded gasket and a restraining force is applied to the anvil tip in a very efficient manner.

A substantial gain in volume can be obtained by substituting a cubic arrangement for Hall's tetrahedral concept.

Hinged and Articulated Cubic Frame. By hinging and articulating a cubic frame with six rams converging on the test specimen, Fig. 15, an increased volume is obtained in the cavity assembly, although the cubic arrangement requires 50 per cent more rams (six instead of four). However, the volume of a cubic assembly is about $2^{1}/_{2}$ times that of the equivalent tetrahedral piece so that the utilization of the unit is substantially improved.

Prismatic Specimens. To obtain prismatic (elongated) specimens, a triangular arrangement, Fig. 16, is used. Each side of an articulated hinge frame contains one or more cylinders. Operated simultaneously, these transmit the pressing effort through appropriately shaped anvils onto the test assembly. Although this unit looked quite different from all previous ones, it still incorporates the four basic concepts; namely, the massive support in the anvils, the plasticized gasket, the spatial arrangement of rams, and the articulated hinge frame. The two ends of the basically prismatic arrangement are closed by auxiliary cylinders or by simple support plates.

NBS Unit. To provide an inexpensive unit approximating the performance of more intricate spatial ram arrangements, the National Bureau of Standards suggested a unit shown in Fig. 17. In this basically tetrahedral unit the three lower rams are arranged slidingly within a tapered retainer sleeve. The fourth anvil at the top, actuated by an outside force, energizes the system. This unit performs quite satisfactorily as long as the ratings are low (100 to 200 ton total pressing force on each ram). In larger sizes certain operational problems arise: (*a*) The friction of the lower three rams against the retainer sleeve is transmitted to the contact area between anvils and the test assembly thus distorting the pressure distribution and influencing unfavorably the life of the anvils; (*b*) the lower three anvils have at the best a line contact with the retainer sleeve except in the lowest position which they never reach in actual operation. This line contact causes excessive wear. In addition, the concentrated reactions of the lower anvils against the retainer sleeve distort the sleeve.

Tetrahedral and Cubic Units. Returning to the discussion of the tetrahedral and cubic units with the articulated hinge frame, these can be scaled up to substantial dimensions. Ram ratings of 2000 tons have been built and 8000-ton ram ratings have been designed. A tetrahedral unit with four 2000-ton rams permits the generation of pressures of 100 kilobars (1,500,000 psi) in a pyrophyllite tetrahedron with $2^{7}/_{8}$-in. edge. The volume of such tetrahedral is 2.8 cu in. A corresponding 2000-ton cubic configuration allows the use of a test-assembly cube with an edge $1^{7}/_{8}$ in. long and with a volume of 6.55 cu in. At 50 kilobars (750,000 psi) the same 2000-ton cubic assembly allows the use of a cube with a $2^{5}/_{8}$-in. edge and a volume of 18 cu in. Fig. 18 illustrates the dependence

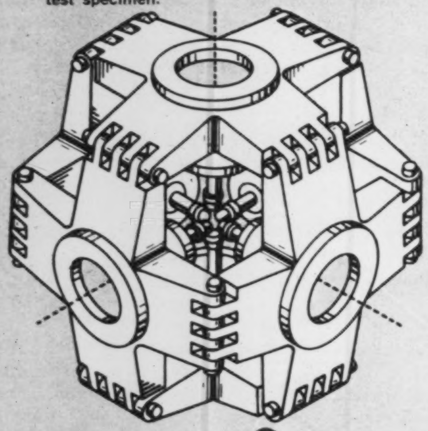


Fig. 15 Substantial gain in volume (2½ times that of an equivalent tetrahedral piece) is obtained by substituting a cubic for a tetrahedral concept. A hinged and articulated cubic frame has six rams converging on the test specimen.

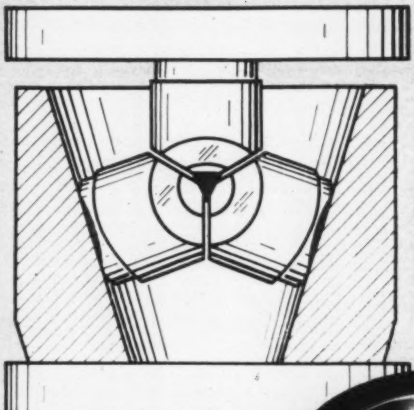
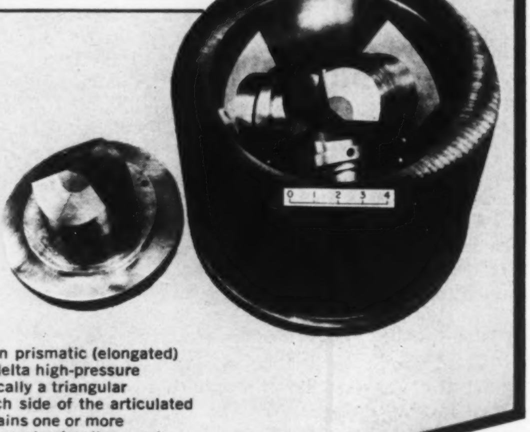


Fig. 17 An inexpensive approximation of the performance of more intricate spatial ram arrangements developed by NBS is basically tetrahedral. The three lower rams are arranged slidingly within a tapered retainer sleeve. The fourth anvil, at the top, actuated by an outside force energizes the system.



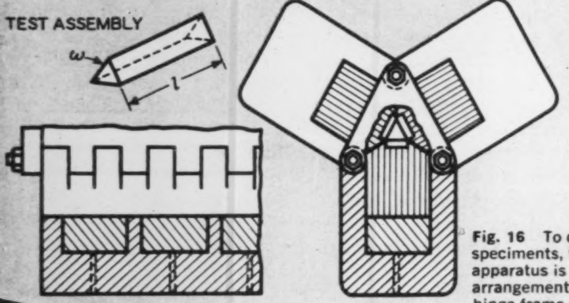


Fig. 16 To obtain prismatic (elongated) speciments, the delta high-pressure apparatus is basically a triangular arrangement. Each side of the articulated hinge frame contains one or more cylinders which operate simultaneously to transmit the pressing effort through appropriately shaped anvils.

of the size of the test assembly on the rating of the unit.

Unfortunately, the total volume enclosed between the anvil tips cannot be occupied by the specimen. A substantial portion must be occupied by the pressure-transmitting plasticized medium (pyrophyllite or the like). Still, specimens of $1^1/_4$ in. diam and $2^1/_2$ in. long can be processed in the 2000-ton cubic unit. A prismatic configuration with a 2000-ton rating would allow the generation of 100 kilobars in a specimen more than 5 in. long. The 8000-ton units would allow, of course, the use of still larger specimens.

Hydrostatic Arrangement. The multiram arrangement in an articulated hinge frame has resulted in a very substantial increase of specimen sizes. However, the frames are rigid and do not allow the changeover from a tetrahedral to a cubic or prismatic configuration. To obtain greater versatility, a different structure was developed for the interchangeable use of tetrahedral, cubic, and prismatic arrangements; shown in Fig. 19 with a cubic anvil arrangement. Four of the six anvils can be seen abutting against the test assembly represented by the small circle in the center. The anvils are so arranged that space remains between two neighbor anvils allowing their advance when the plasticized gasket extrudes from the test assembly into the space. The entire anvil assembly is contained within a resilient shell which, in turn, is located within a pressure vessel. A small amount of pressurized liquid introduced into the spherical space between the pressure vessel and the rubber layers exerts pressure upon the resilient shell which, in turn, transmits the pressure to the anvils thus generating the compressive force then applied by the anvils upon the test-specimen assembly.

Apart from the simplification in structure, this so-called hydrostatic arrangement promises fewer problems when scaling it up beyond the present limitations of the articulated hinge design, and it is being incorporated in a number of units at present. Upon completion of this work a further simplification can be expected.

Progress in Anvil Design. Progress in anvil design for multiram configurations is illustrated in Fig. 20, which shows: (*a*) An anvil with a very substantial tungsten-carbide tip placed within a confining steel ring and supported by a tapered steel base; (*b*) a somewhat less expensive design in which the tungsten-carbide tip has been split into two layers so that only the upper one requires frequent replacement; and (*c*) a simplified design with a comparatively small tungsten-carbide tip which has proved quite satisfactory for pressures up to 100 kilobars (1,500,000 psi). Currently, steel anvils—without tung-

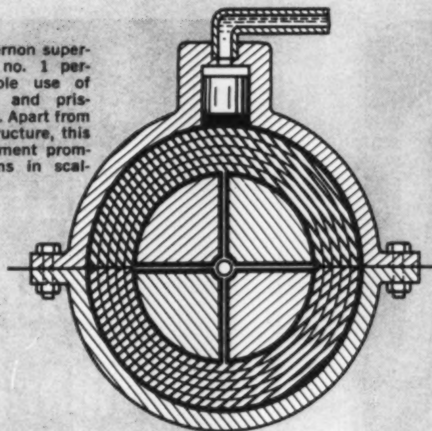


Fig. 19 The Mt. Vernon super-high-pressure unit no. 1 permits interchangeable use of tetrahedral, cubic, and prismatic arrangements. Apart from simplification in structure, this hydrostatic arrangement promises fewer problems in scaling up.

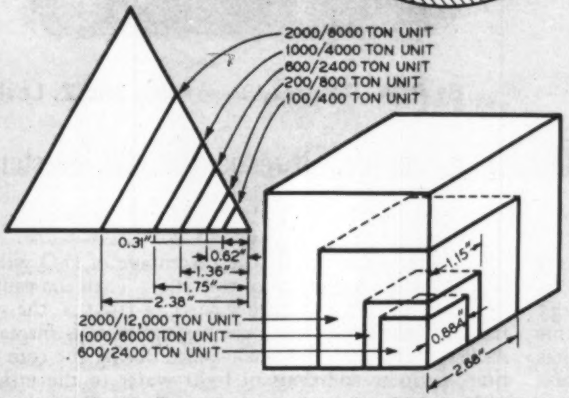


Fig. 18 The dependence of the size of tetrahedral and cubic units on the rating of the unit.

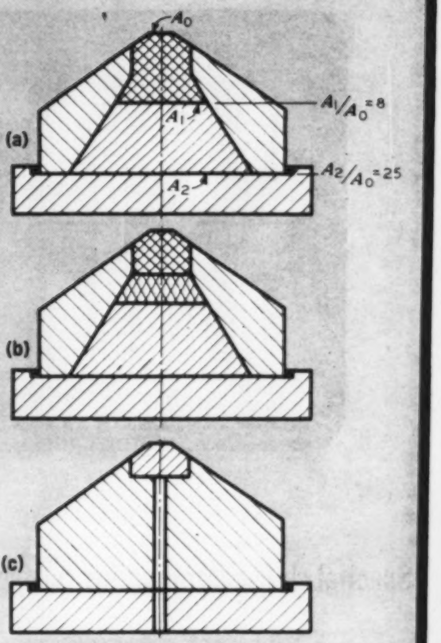


Fig. 20 Progress in the anvil design for multiram configurations: (a) An anvil with a very substantial tungsten-carbide tip placed within a confining steel ring and supported by a tapered steel base; (b) a simplified design with a comparatively small tungsten-carbide tip has been split into two layers so that only the upper one requires frequent replacement; and (c) a simplified design with a comparatively small tungsten-carbide tip which has proved quite satisfactory for pressures up to 1,000,000 psi.

sten carbide—are being used up to 70 kilobars(1,000,000 psi).

High Temperature

The majority of modern high-pressure arrangements can be used for simultaneous generation of high temperatures. Heating can be accomplished either by a thermit charge surrounding the specimen or by electrical resistance. The current is passed through the specimen if it is conducting and does not have exorbitantly low resistance. Specimens with a resistance of 0.001 ohm would allow the generation of 1 kw by the application of 1 volt across the specimen.

If the specimen is nonconducting or resistance is too low, heat can be generated in a separate resistance element placed near the specimen. In both direct and indirect resistance heating, plungers or anvils can be used to introduce the current into the test assembly.

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SSCR

Spectral Shift Control Reactor

By R. W. Deuster,[1] Mem. ASME, and Z. Levine[2]

Spectral-shift control varies D_2O concentration during core life. It reduces capital investment

WATER reactors enjoy the distinction of having reached the most advanced state of development of any reactor type. However, the cost of the energy produced is still too high. In an effort to break this high-cost barrier, The Babcock & Wilcox Company has devoted considerable effort toward the development of a variation of the Pressurized-Water Reactor, PWR, known as the Spectral-Shift-Control Reactor, SSCR. The thermodynamic aspects of the SSCR are identical in nature to those of a conventional light-water PWR, and other aspects of existing water technology are also utilized to the maximum extent possible. The present design studies have drawn heavily upon B & W's experience with the Consolidated Edison thorium reactor and the nuclear merchant-ship reactor.

Principles of Operation

The SSCR is a variation of the PWR concept wherein reactivity control is accomplished by varying the concentration of a D_2O-H_2O mixture in the primary loop of the reactor. The addition of D_2O changes the relative number of neutrons at any particular energy (that is, shifts the neutron spectrum), resulting in more neutrons at slightly higher energies and more absorptions in fertile material. The resulting increase in resonance absorptions in the fertile material allows a larger amount of fissionable material to be safely controlled (that is, the reactivity of the fuel lattice decreases with an increasing deuterium-to-hydrogen ratio because the "slowing-down power" for D_2O is only 13 per cent that of light water). The relative amount of U-235 that just results in a critical mass for a typical water-reactor is shown in Fig. 1 as a function of heavy-water concentration.

In operating an SSCR, the percentage of D_2O will be highest at the beginning of core life. Then the neutron spectrum is shifted to higher energies (that is, the spectrum is "hardened") and the critical mass is increased. As fissionable material is consumed during the core lifetime, periodic additions of light water to the mixture make the neutron spectrum more thermal and decrease the critical mass, thus increasing the relative effectiveness of the fuel which remains. In this manner, varying the D_2O concentration changes the reactivity of the core to offset the long-term effects of fuel burnout and isotope build-up. The loop will contain almost all light water at the end of core life.

Controlling With the Spectral Shift

Considerable design difficulties exist in pressurized-light-water reactors because of the limitations imposed by the reactivity-control system. Neutron-absorbing control rods have relatively little reactivity worth because of the small neutron-absorption mean free path in the reactor lattice. To get long core life, large numbers of rods or poisons (burnable or soluble) must be used. Burnable poisons within the fuel frequently have improper burnout characteristics, and soluble poisons in the loop pose significant long-term questions concerning the loop materials themselves. The common disadvantage of all these control methods is that they waste neutrons and increase fuel costs.

Starting with a fresh core in a cold SSCR, the reactivity effects of a heavily loaded, long-life core can be compensated for as shown in Table 1. The temperature effect takes place in the first few hours during reactor start-up; build-up of equilibrium xenon and samarium takes a few days, while lifetime changes occur during hundreds of days. Concentration of D_2O in the moderator will be varied to control these slower-moving reactivity effects.

The fast-moving transient reactivity requirements of xenon and the power coefficient, imposed by load changes

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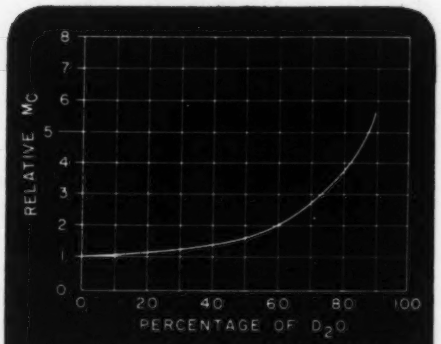


Fig. 1 The relative amount of U-235 that just results in a critical mass is shown for a typical water-reactor configuration as a function of heavy-water concentration

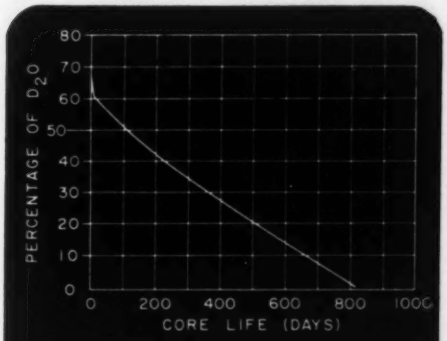


Fig. 2 The D_2O concentration would be changed as a function of time; the percentage of D_2O would be highest at the beginning of core life and decrease with time

The Babcock & Wilcox Co., Atomic Energy Div., Lynchburg, Va.

and nuclear-fuel costs, and conserves nuclear reserves. It is based on our present technology.

of the electrical network, are handled either by rods alone or by a combination of rods and variations in D_2O concentration. Safety shutdown will always be compensated for by control rods. However, when the reactor operates at full power, essentially all control rods will be withdrawn and inserted only to reduce reactor power.

The D_2O concentration would be changed as a function of time, Fig. 2. The curve shows the early build-up of xenon and samarium and the lifetime variation.

Advantages of Spectral Shift

Some advantages of spectral-shift control are immediately attainable, while others are only potential.

1 Higher Power Density. By removing the control rods from the core during full-power operation, the power peaks normally found in the core may be reduced and the average power of the core substantially increased. Where once 700 tmw was considered an excellent output for a single PWR core, the attainment of 1000 tmw now seems relatively easy, and higher powers are in the offing. This portends consideration of the SSCR by any utility interested in plants of 300 emw or greater—the capacity range where nuclear power is most likely to lead to economically competitive power.

2 Uniform Fuel Burn-Up. Avoidance of power peaks yields another direct benefit. It removes the obstacle of irradiation-exposure limitations. Where the average was formerly from $^1/_4$ to $^1/_3$ of the maximum irradiation, spectral-shift control permits the average to be $^1/_2$ (or perhaps even a greater fraction) of the maximum allowable irradiation.

3 Lower Capital Costs. The benefit of a higher power density is a reduced cost per kw of installed capacity. Since the costs of equipment in a water-reactor primary loop are relatively insensitive to power level, the increase in core power density results almost in an inverse ratio of capital cost per kw for the reactor system.

4 Higher Thermal Efficiency. With more uniform power distribution, the average reactor temperature can be increased without compromising heat-transfer criteria. Since more heat is generated in the average channel, the average exit temperature more nearly approaches that of the hottest channel. The higher temperature permits higher-pressure secondary steam and turbine efficiency.

5 Longer Core Lifetime. Since the amount of excess reactivity available for fuel burn-up may be easily varied by changing the D_2O concentration of the primary loop, this theoretically allows core lifetimes to be extended far beyond the margins presently imposed by materials limitations. Since irradiation damage to oxide fuels appears to be more hypothetical than actual, lifetimes of future cores may be limited only by the excessive neutron absorption in the fission products themselves.

6 Lower Fuel Costs. For all practical purposes, longer core life means lower costs per kwhr because the "fixed" part of the core cost (fabrication and reprocessing) is spread over more kwhr.

7 Improved Conversion Ratio. The spectral-shift-control concept was conceived as a means of economizing on neutrons. The valuable neutrons that would be lost to control rods or poisons are invested in fertile material and create new fissionable material, much of which is burned in situ, extending the core life. Although this advantage may be obtained on either the uranium or thorium cycle, the future utilization of U-233 cores offers

Table 1 Typical Reactivity Control Requirements

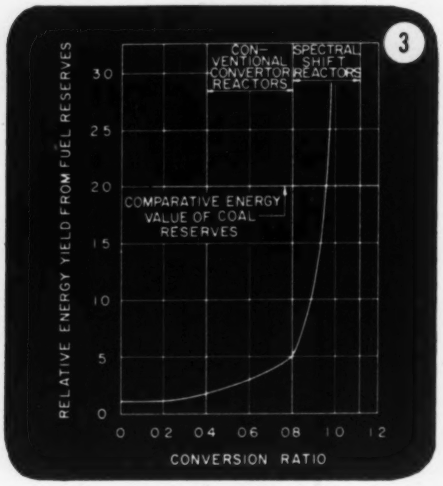
Reactivity Effect	Holddown by control rods, per cent ΔK	Holddown by spectral-shift D_2O concentration, per cent ΔK
Temperature deficit	...	8.4
Equilibrium xenon and samarium	...	2.8
Fuel burnout and isotope build-up (lifetime)	...	19.0
Doppler power coefficient	2.7	...
Safety shutdown margin	3.0	...
Xenon transient (after shutdown)	2.1	...
Total	7.8	30.2

Spectral Shift Control Reactor

Fig. 3 The importance of a high conversion ratio is shown by the plot of the energy yield from fissionable material versus the conversion ratio. Achievement of a conversion ratio of about 0.95 extends available fissionable-material reserves by a factor of 20.

Fig. 4 The expenses for fissionable material and fuel inventory, and the sum of these two expenses, are compared for various reactor-control concepts. Since these components of fuel cost are most affected by the inherent features of control methods, the sum provides an adequate index of comparison.

Fig. 5 The same expenses used in Fig. 4 are compared for SSCR's with various fuel loadings, low cross-section cladding. Case VI is repeated from Fig. 4 to provide a better comparison.



substantial economic advantages. The investment of one neutron in Th-232 yields the highest return in terms of additional energy-generating material.

Breeding Possibilities

The most interesting possibility is that the SSCR may be able to utilize thorium and U-233 in a core designed specifically for the ultimate in conversion ratio. Theoretical work[3] shows the possibility of reaching an actual breeding gain, although this may be limited by practical economics. Before the economics of breeding can be accurately predicted, however, certain deterrents must be recognized: (*a*) Present Zircaloy fuel-cladding materials, which are low in cross section, must still be investigated to prove acceptable long-life qualities; (*b*) recycling the U-233 U-235 mixtures and fabrication of fuel elements from this material need development; (*c*) physics experiments are needed to refine the calculations on cores containing large quantities of U-233.

The potential benefits of high-conversion ratio, Fig. 3, or thermal breeding have not been stressed sufficiently well by the reactor industry because of the difficulty of achieving high conversion with any of the previous reactor concepts. Achievement of a conversion ratio of about 0.95 extends available fissionable-material reserves by a factor of 20; achievement of breeding extends available reserves by as much as a factor of 200. Inasmuch as the SSCR now offers the practical possibility of achieving the high-conversion objective, its development should be accelerated.

Two other points are significant in Fig. 3:

1 Present estimates[4] of available known reserves of uranium would provide only $^1/_{20}$ of the energy available from known coal reserves if only fully enriched U-235 were used in cores having zero conversion ratio. Present military reactors fall in this category.

2 This theoretical curve is based on converting one fertile atom into an equivalently useful fissionable atom. Actually, this is not achieved because: (*a*) Pu-239 converted from U-238 is a fissionable atom which, in thermal reactors, is less useful than U-235 and impractical to recycle; in thermal reactors, the curve of actual usefulness for Pu would fall far below the plot; (*b*) U-233 converted from Th-232 is a fissionable atom which is better than U-235, can be recycled, and is the best fuel for thermal reactors; in thermal reactors, the curve of actual usefulness for U-233 lies well above the plot.

Cost Comparison

Capital Costs. The significantly higher capital investment required for nuclear-power-plant construction over conventional must be reduced. Capital costs for three kinds of water reactors are compared in Table 2—an advanced PWR, a BWR, and an SSCR—all in the 300-emw range. Data for the PWR and BWR are from the power-cost normalization studies performed for the AEC's Ten-Year Program.[5] The SSCR data are based on a recently completed design by B&W. The comparison demonstrates that the increased power density made possible by spectral-shift control effects a very substantial reduction in the capital cost per kw. The achievement of less than \$200 per ekw is considered a major break-through in nuclear-plant design, especially since the \$200 per ekw includes ample allowance for contingency and interest during construction.

The 3.8 mills per kwhr capital charge of the SSCR is 1.1 mills per kwhr below that of the present PWR shown in Table 2. In fact, comparison of the present SSCR and the ultimate PWR[6] shows a 0.6 mill per kwhr advantage for the SSCR. Approximately half of the present 1.1-mills-per-kwhr advantage is displaced, however, when the capital charges and the expected losses of D_2O are taken into account. The writers are confident that the D_2O expenses will be reduced upon completion of the experimental physics program[7] and other studies.

Fuel Costs. Several cases of fuel-cycle economics have

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[3] M. C. Edlund, "The Spectral Shift Control Reactor (A Variation of the PWR)," presented at IAEA Vienna Conference, September, 1960.

[4] "Energy From Uranium and Coal Reserves," TID-8207, U. S. Atomic Energy Commission, Office of Technical Information, 1960.

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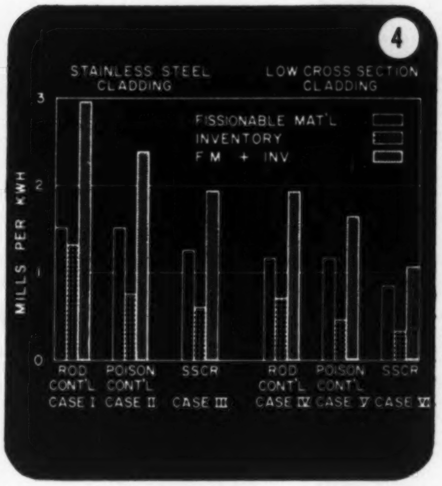
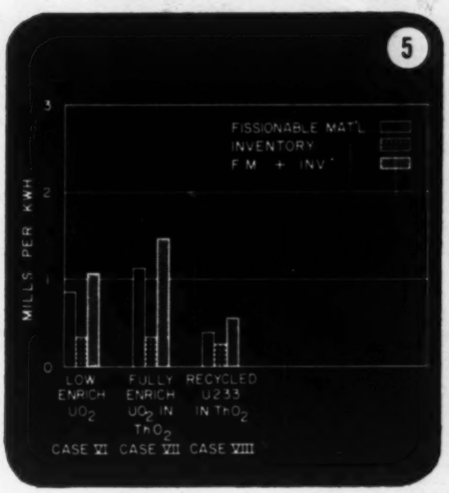




been evaluated to provide data for comparison of an SSCR with other designs. All cycles are based on reactors operating at 1090 tmw for an average fuel burn-up of 20,000 megawatt-days per metric ton of oxide. The net station heat rate is approximately 11,000 Btu per kwhr and the plant factor is 0.8.

Low-Enriched UO_2 Cycle. The net fissionable-material expense, the fuel-inventory expense, and their sum for several cases are illustrated in Fig. 4. These components of fuel cost are most affected by the inherent features of the control methods under comparison, so that the sum should be an adequate index of comparison. In addition to pointing out advantages for spectral shift, the savings from low-cross-section clad becomes readily apparent. The inventory saving between Cases I and II is principally attributable to the improved peak-to-average power ratio afforded by the soluble poison. The fissionable-material saving between Cases II and III comes from the improved conversion ratio.

Thorium Cycle. If the operation of the reactor began with low-cross-section clad elements, the preferred fuel would be fully enriched UO_2 in ThO_2. By starting U-233 production on the first core, utilization of recycled U-233 is achieved earlier and leads to the ultimate in low fuel cost. A comparison of fissionable-material and inventory costs for cores of this sort is continued in Fig. 5.

Cores fabricated with recycled U-233 will not be available for several years even if development is initiated immediately. Discounting the availability of the U-233 being produced in the reactors currently employing thorium-loaded cores, substantial quantities of U-233 could come only from an SSCR core initially fueled with fully enriched UO_2 in ThO_2. The first core would be spent and ready for reprocessing in 1967 if construction of the first SSCR plant begins immediately. The U-233 from this first core could be recycled for the third-core loading to start operation in 1970. Thus concerted efforts toward developing and refining the data and methods, which take advantage of these projected savings, should be initiated immediately.

Utilizing the U-233 produced in the core of the Consolidated Edison thorium reactor, or other thorium-cycle reactors, would permit recycling of U-233 U-235 mixtures into the second SSCR core approximately $2^1/_2$ years earlier. If the work is started soon, there is sufficient time to permit the necessary recycle development work to be accomplished for this earlier cycle.

Summary

The analysis of a central-station SSCR plant has demonstrated several advantages. By far the most significant are: (*a*) Reduced capital investment, (*b*) reduced nuclear-fuel costs, (*c*) conservation of nuclear-fuel reserves through higher conversion.

These advantages are obtainable now from an SSCR which is based on present technology and can be constructed immediately. This plant is economically competitive now with conventional fossil-fueled plants in some foreign countries and is nearly competitive in certain high-cost fuel areas of the United States.

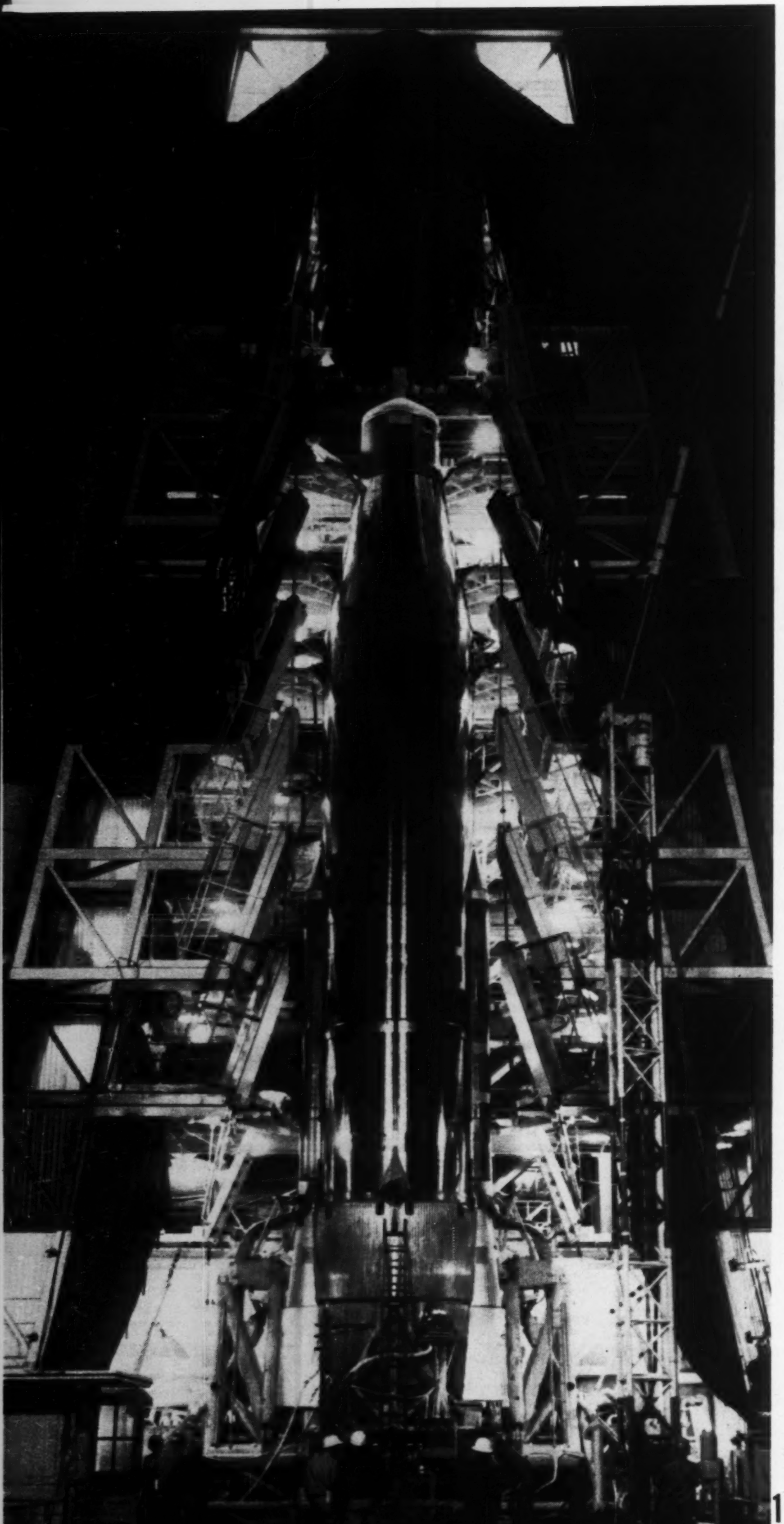
Calculations indicate the further possibility of achieving conversion ratios near 1.0, possibly even greater (that is, breeding), in an SSCR using recycled U-233 fuel. The U-233 fuel cycle permits full realization of the advantages of spectral-shift control and potentially has the lowest fissionable material costs of any water reactor.

Acknowledgment

The writers are especially grateful for the co-operation of Messrs. R. A. Webb, H. S. Barringer, and T. M. Schuler for performing the lifetime calculations and assisting in the proper interpretation of the results.

Table 2 Capital-Cost Comparison, Millions of Dollars

	PWR 300 emw	BWR 300 emw	SSCR 340 emw
Direct and indirect construction costs.	$61.3	$65.9	$54.2
Start up costs..........................	$ 0.5	$ 0.5	$ 0.5
Subtotal	$61.8	$66.4	$54.7
Contingencies, 10 per cent............	$ 6.2	$ 6.6	$ 5.5
Subtotal	$68.0	$73.0	$60.2
Interest during construction, 8.1 per cent................................	$ 5.5	$ 5.9	$ 4.9
Total capital cost....................	$73.5	$78.9	$65.1
Capital cost, $ per ekw..............	245	263	191
Fixed charges, @ 14 per cent, 0.8 plant factor, mills per kwhr............	4.9	5.3	3.8
Heavy water (nondepreciating item) $9,200,000 @ $12^1/_2$ per cent, 0.8 plant factor, mills per kwhr.............	...	...	0.5



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The

"You've got to glamourize mechanical engineering."

The man who made that statement to us was Philip Sporn, Hon. Mem. ASME, President of American Electric Power Company. He didn't mean phony glamour. He meant that we had the task of bringing out the excitement and adventure of the engineer's career. He wanted the public to know that engineers—not scientists—are the men who bring rockets, space ships, and nuclear power to reality. Many of the great adventures of today are being lived by engineers.

We are not alone in this endeavor. The Engineers' Council for Professional Development offers a booklet called "Engineering, A Creative Profession," in which they tell what an engineer does, and discuss the student's choice of a college. For copies, contact ECPD, Room 302, United Engineering Center, 345 East 47th Street, New York 17, N. Y.

The four pages presented here are inspired by a booklet published by the Department of Mechanical Engineering, College of Engineering, The Ohio State University, a booklet intended to get the drama of engineering across to the prospective student. Wisely, they built their presentation around pictures, photos of machines mechanical engineers have created. We give you some of the pictures and commentary with which Ohio State's educators drove home their point.

For the pictures and much of the material on these four pages, we are indebted to the Department of Mechanical Engineering, College of Engineering, The Ohio State University, Columbus, Ohio.

Lively Art of Mechanical Engineering

What does a young man see when he contemplates mechanical engineering as a career? Suppose he asks, "What's this mechanical engineering got?" Your answer won't be complete unless it conveys something of the thrill of creative achievement.

They define mechanical engineering as the branch of engineering which studies the conversion of energy from one form to another, the design of all types of machines, the instrumentation and control of all types of physical processes, and the control of man and machine environments. They offer examples of exotic machinery which the profession is asked to produce.

Problem: The human heart consists of two pumps. Each has two valves, one which lets in blood, one which lets it out. Sometimes a valve becomes defective, and sometimes children are born with defective valves. Design a replacement valve which must operate 36 million times a year. The replacement valve must be made of a material which will not poison or attack the internal organs of the human body.

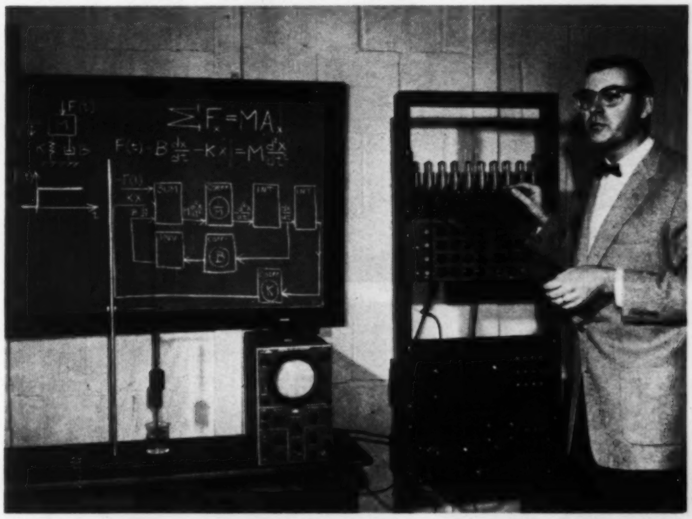
Problem: The National Aeronautics and Space Administration would like to land a set of instruments on Mars. These instruments will collect and transmit information about Mars back to earth. NASA would like to know how these instruments, which work so well in Earth's atmosphere, will perform on Mars. Design a chamber which can simulate Mars' environment so that the performance of these instruments can be tested in Mars' atmosphere.

Pictures

(1) Its stainless-steel tanks gleaming under floodlights, the Atlas 10-B missile that orbited the earth is shown in its service tower at Cape Canaveral. Except for its jettisoned booster-engine package, the entire 82-ft rocket went into orbit on Dec. 18, 1958. Mechanical engineering is involved in the design of rocket engines, guidance system, tank and fuel supply system.

(2) This analog computer being demonstrated at Ohio State is used exclusively for classroom demonstration in feedback-control courses taught in the Department of Mechanical Engineering. This demonstration shows a simple spring-mass vibrating system with viscous damping with its analog on the computer.

(3) The automatic sculpting machine casts long shadows into the future. The template on the right controls the machining done on the



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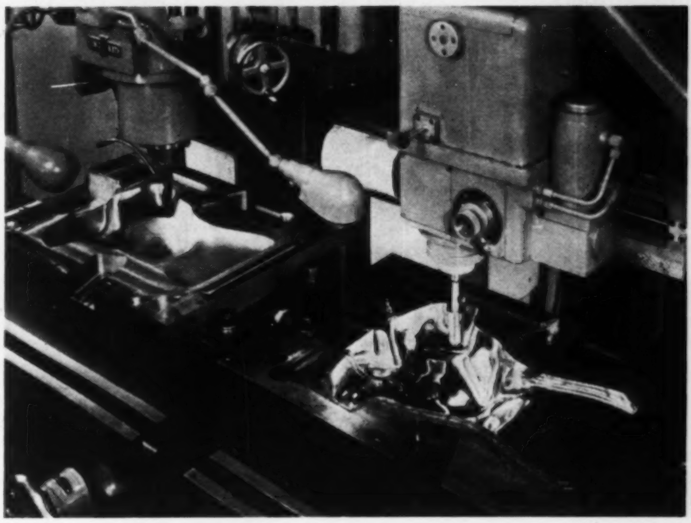

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The Lively Art of Mechanical Engineering

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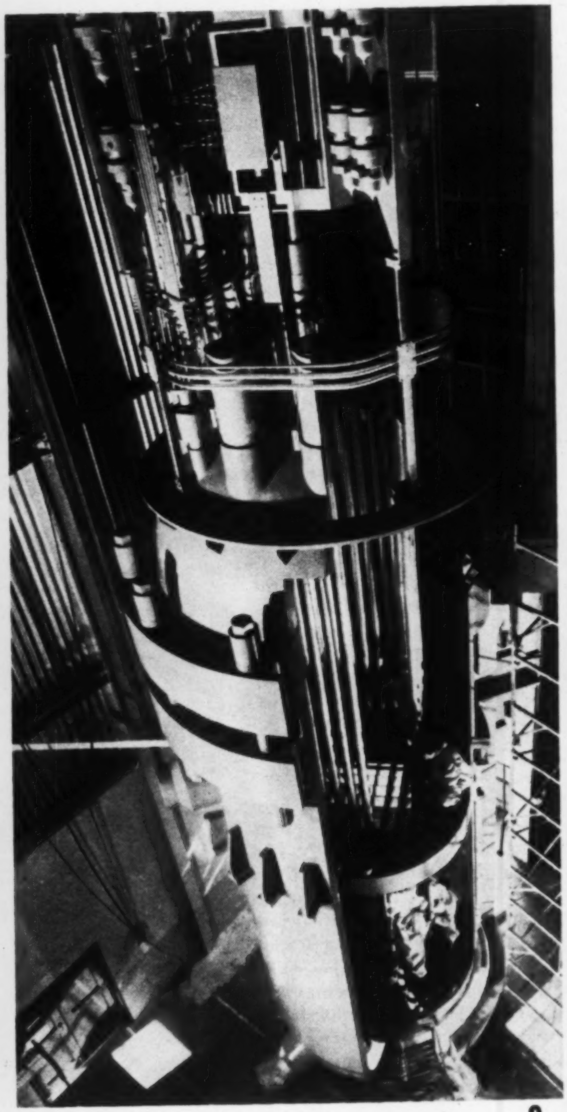

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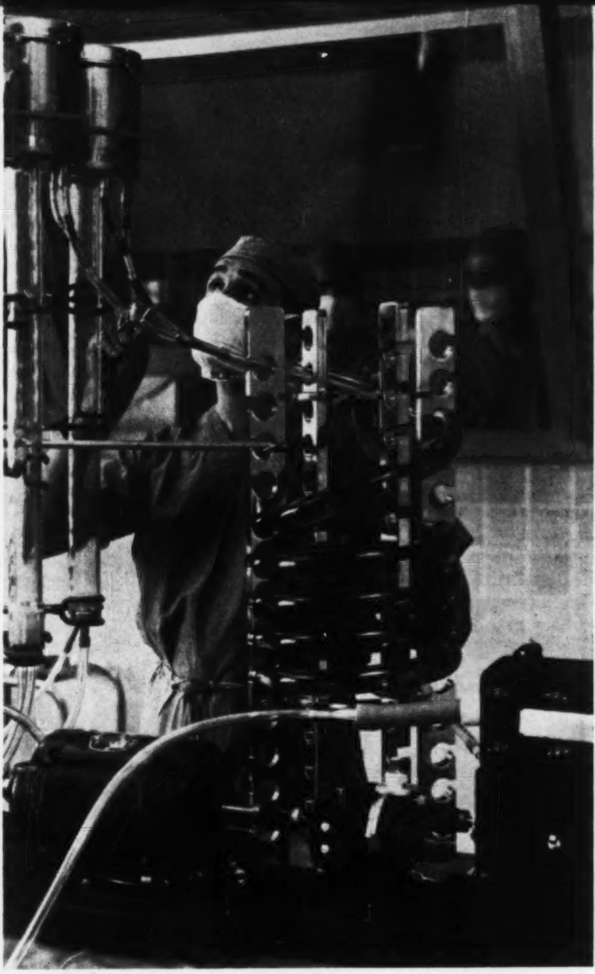

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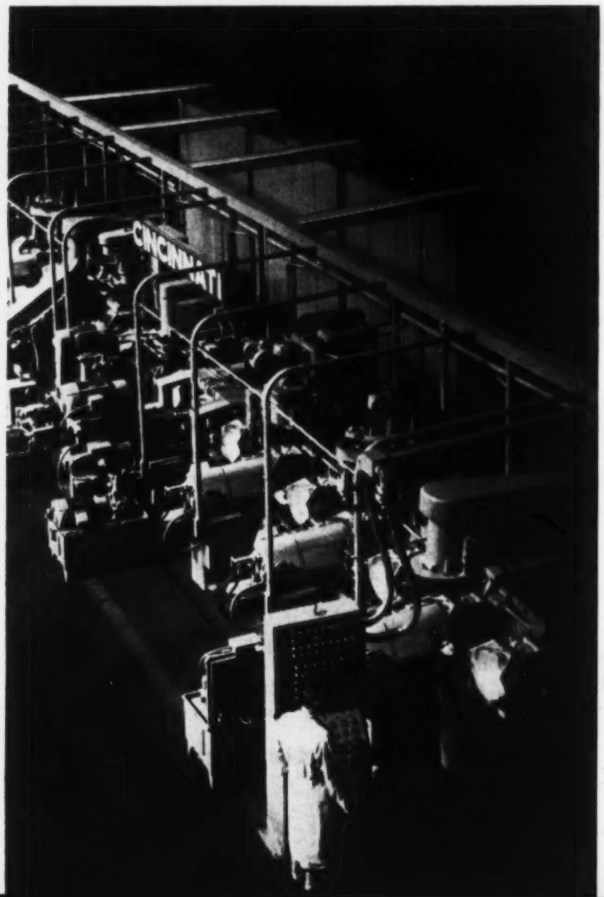

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part at the left. Tomorrow's aircraft and missiles will demand maximum strength from every ounce of metal and call for more intricate and precise machining. Contour milling on a large scale presents such complex control problems that physical models and templates may be replaced by coded punch tape.

(4) Water flow patterns in a pump test are used by mechanical engineers to study the design of intake tunnels that bring circulating water into electric-power generating stations. This pump test circuit is used to determine the effects of pump submergence, inlet flow turbulence, and variation in the design of pump components.

(5) This photograph shows the roots of a turbine blade as they fill in the turbine wheel. Both parts are made of plastic and illuminated with polarized light so that the mechanical engineer may determine the areas where parts would be most likely to fail. Where the stripes are closest together are the regions of highest stress where failure would be most likely to begin.

(6) The 45-ft-high full-scale mockup of the pressurized water reactor installed at Shippingport, Pa., site of the nation's first nuclear power plant. Inside the vessel are shown long tubes which will contain the control rods of neutrons-absorbing material. The control rods enable the engineers to control the rate at which atomic fission will proceed in the reactor.

(7) Here the mechanical engineer has teamed with the surgeon to produce a heart-lung machine for use during surgery. The patient's heart and lungs are bypassed so that the surgeon has a dry and clear field to work in. The machine takes over the pumping of the patient's blood. As the blood comes out of the spiral section, it has the air removed from it and oxygen added before it is returned to the patient's arteries.

(8) The automatic transfer machine takes in a crude casting at one end and turns out a finished product at the other, after doing over 200 machining operations. These machines are already being used to set up competely automated factories. The mechanical engineer is importantly involved in the design of such transfer machines.

Picture Credits. 1 General Dynamics Corporation; 2 The Ohio State University; 3 Cincinnati Milling Machine Company; 4 Westinghouse Corporation; 5 General Electric Company; 6 Westinghouse Corporation; 7 B. F. Goodrich Company; 8 Cincinnati Milling Machine Company.

FOREIGN COMPETITION

-ITS TOTAL CHALLENGE

Time is on our side only if we get hold of ourselves and achieve the economic and the political virility of which we are capable

By J. Keith Louden, Fellow ASME
Chairman, Board on Technology, ASME

THE sixties have been described in many ways—as the Soaring Sixties, the Troubled Sixties, the Confused Sixties, and by some more thoughtful people as the decade of decision that will witness the resolution of the power struggle between the forces of evil and the forces of freedom for the control of the world.

No matter what other problems we may have, none transcends this fundamental struggle, and no one is excused from it. To understand its nature, particularly from the viewpoint of this country, we must recognize the total problem we face.

Much has been said about foreign competition and its impact on our economy. When we speak of foreign competition we are thinking basically of the economic factors and failing to recognize that the foreign competition is ideological and cultural as well as economic.

In discussing the total nature of this competition, I would like to review it with you in your role as professional engineers and professional managers.

Total Involvement

The struggle is one that goes beyond our nine-to-five lives, and cannot be palmed off on that vague "someone else" or "the government." We are in a struggle against evil, whether it be evil involving basic philosophies of life such as communism versus freedom, or evil in the form of delinquency, both adult and juvenile, poverty, inflation, and their underlying factors and causes. We are not going to find solutions in the next 24 hours.

An eminent theologian has voiced the fear that if the Christian Church did not begin at once to accept its responsibility to provide leadership in this war against total evil, this era in history could well be known as the Post-Christian Era.

Is it not equally true that if we of management do not fully adopt the role of trustee and work toward attaining the natural objectives of business—which are to create a customer, maintain a healthy physical and financial structure, and provide the individual the basic satisfactions of personal accomplishment and a sense of belonging—that this era could also be known as the Post-Management Era?

Is it not equally true that if leaders of labor do not rise to their position of great responsibility their power in the economy demands, that this era could also be known as the Post-Free Labor Era?

When the forces of evil take over, whether it be com-

Condensed from a speech delivered before the Trenton and Pittsburgh Chapters of the Society for Advancement of Management—and other organizations—during the winter of 1961.

munism, plain gangsterism, or fascism, the first people to the wall are those of the clergy, management, labor, government, and education who failed their fellowmen by not providing strong, objective, courageous leadership while there was still time, but who nevertheless are considered dangerous by the dictators of evil.

We must keep ourselves strong as a people. We must keep ourselves healthy economically, spiritually, physically, and mentally. We must remember that we are the hope of not only the free world but of those who wish to be free, and if we continue to let ourselves and our nation grow soft and weak, and go down, with us go the hopes of freedom-loving mankind everywhere.

We Underestimate Ourselves

We underestimate ourselves and our importance as a people and a nation. This is not just being humble and modest, but rather emphasizes our lack of knowledge of what is going on in the world and the role we play, whether we like it or not. Of all the factors of interest I found on a recent trip to Europe, the one that impressed me the most was that I found myself constantly struggling to match the thorough and detailed knowledge of the economic and political life of my own country as displayed by Europeans, and I feel myself to be reasonably informed.

Europeans, by the very nature of their history and geography, are forced to be keenly aware of the trends, the tides that influence nations and people. We, because of our geography and history, are not so aware. That is a gap—a lapse—we must make up.

Most Europeans are gravely concerned about us and our ability to remain strong and the bastion of the free world. They are concerned over the fact that we have, through self-indulgence, priced ourselves out of many world markets and can no longer compete on an equal basis with the European and Japanese manufacturers, to say nothing of the rising power of Soviet industry and its future impact on the world economy.

They believe that the flight of capital and industry to Europe, Japan, and elsewhere to avoid high labor costs, high taxation, and the like, will further weaken our domestic economy. All this, in their minds, adds up to the fact that Khrushchev stands a better than even chance to win as he believes he will, on the economic front, because we will destroy ourselves economically. They know if we go down, we pull everyone with us.

Khrushchev is betting that we as a people haven't the moral fiber and courage to face up, trim the fat off our minds and our economy, and control the forces of inflation—that we are no longer a dedicated people, that we don't want to be realists, to face up, to sacrifice. Will we prove him right? That is the question all the peoples of the world are asking you and me with fear in their eyes and hope in their hearts.

Four Economic Issues

There are four economic issues at the international level facing the United States:

The development of regionalism as evidenced by the common markets of Europe, and the greater industrialization of not only these areas but the so-called "backward" areas of the world.

The keen desire of peoples to raise their own standard of living.

The challenge of the Soviet and their controlled economy.

The fourth issue is the preservation of the dollar.

There is no easy way out of the situation in which we find ourselves. We are not going to close the gap on wage differentials for years to come. The Germans tell me it will take at least five years for them to close this gap significantly, even if we stand still in our general wage levels, and that they don't think we can or will do. While gravely concerned about us, nevertheless they are not going to let us up, but they do wish we would get hold of ourselves and face up to our problems.

One thing we must do, with the help of labor leaders if possible, but without them if necessary, is to sell our own employees on the total nature of foreign competition and what it means to them. Their jobs are at stake, and so are ours. Our country's life is at stake, and with it the life of the free world.

Peter Drucker states that the foreign market is the crucial market of our economy, and performance in it will determine our ability to prosper and grow. Yet we have not only lost important segments of our domestic market to imports, but we have lost important segments of our export market.

What then are some of the actions we must take?

1 Accelerate our research and development programs to "out-invent" our competitors, both at home and abroad.

2 Hold the line on wage and salary levels to allow other nations to close the gap significantly.

3 Keep our government spending under control and eliminate deficit spending.

4 Revise our tax structure and depreciation schedules to help business become more competitive.

5 Work for reductions of foreign restrictions upon our exports and intensify efforts to promote our exports.

6 Stop being the rich uncle for the world now that others are able to help.

7 Keep ourselves strong morally, spiritually, physically, and intellectually, as individuals and as families, so that we may prove Khrushchev wrong and thus bring freedom and light to the whole world.

Leadership Must Be Outspoken

We must not let the concept of leadership down. Let us be determined to speak, write, and act the truth—speak the truth when it needs to be spoken to set the record straight. This latter often takes courage. Abraham Lincoln said: "To sin by silence when they should protest makes cowards of men."

Yes, I know we may not always know what is the truth, what are the facts, and what is the proper thing to do. You can't always know. But sometimes what is actually the fact, what is actually the truth, is not as important as the intent, conviction, and courage of the person involved in stating and living up to what he truly and honestly believes.

At times it can become terribly confusing, but there is one question the practicing Christian can always ask himself in these times and that is: "What would Christ do under these circumstances? What would He say? How would He perform?" If people of all religions would ask themselves similar questions, what a change it would make, what a change!

RANDOM VIBRATION

Vibration in rockets can be telemetered to earth, recorded, then simulated by electrodynamic

During World War II various aircraft components and systems failed to operate properly due to the effects of vibration. Some vibration testing, rather crude at first, was applied to components and to systems, in early "environmental laboratories." The general objective was to improve designs and to weed out faulty units that could possibly cause trouble in flight.

The first "shakers" used for this purpose were oscillating tables driven by electric motors, variable-speed drives, and "Scotch yoke" couplings. The frequency range was 600 to 3600 cpm. About 1946 more refined studies of vibration in aircraft led to vibration environmental testing specifications, calling for programmed sinusoidal vibration testing up to 500 cps or 30,000 cpm. Mechanically driven shakers were inadequate; electrodynamic vibration exciters were developed to meet these requirements.

Random Vibration

In the mid-1950's it was observed that vibration measured in jet aircraft and missiles and rockets was seldom sinusoidal (Fig. 1). It was observed that the measured vibration existed over a wide range of frequencies. Sometimes discrete frequencies could be identified (complex vibration) but often a continuous spectrum of energy was found.

The source of this wide-frequency-range vibration, often called wide-band vibration, in a jet, missile, or rocket, is the clouds of hot gas particles being ejected at high velocity from the exhaust. When one listens to the distinctive blast of a rocket engine, one hears audio energy that is composed of a wide band of frequencies.

An oscillogram of random vibration having a continuous spectrum of energy is shown in Fig. 2, along with an energy/frequency plot.

A demonstration with a simple audio system will clarify the latter. The equipment used is shown in block diagram form, Fig. 3. The entire range is heard by closing the bypass switch; the restricted range is heard by opening the bypass switch. The operator can further limit the frequency range by adjusting the controls on the filter to restrict the signal to a relatively narrow band. When this is done, one notices two effects:

1 The loudness decreases as less signal voltage reaches the amplifier and loudspeaker.

2 The wave form on the oscilloscope shows the narrowed frequency range by looking more and more like a sine wave. The wave form shows a fairly "clean" sine wave that varies in amplitude.

Fig. 4 shows an unfiltered random signal together with the same signal after passing through a very narrow electrical filter. The lower trace closely resembles a 100-cps sine wave. Actual systems for testing with random vibration closely parallel Fig. 3.

Since random vibration does not confine itself to discrete frequencies, and since the intensity varies in random fashion, the familiar language of sinusoidal

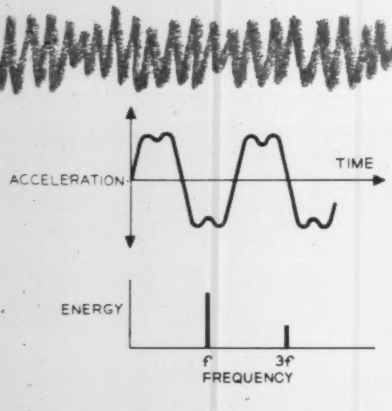

Fig. 1 An oscillogram and energy/frequency plot for a "distorted sine wave," a complex wave. Most of the energy is at a frequency f, but some are at a higher frequency 3f. While motion is cyclic and repetitive, vibratory energy exists at more than one frequency.

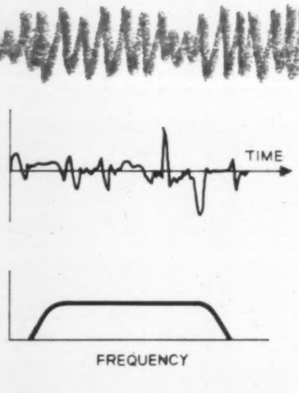

Fig. 2 Oscillogram and energy/frequency plot of random vibration, having a continuous spectrum of energy. Here, motion is neither cyclic ncr repetitive, and vibratory energy exists over a continuous band of frequencies, not at discrete frequencies.

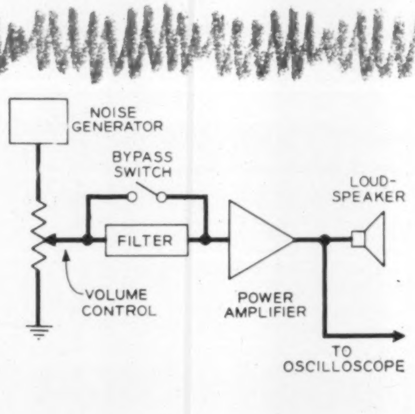

Fig. 3 A simple audio system, the basis of vibration equipment. The noise generator generates a continuous band of frequencies from about 20 to 20,000 cps. In vibration testing, only the portion 20 to 2000 cps is commonly used.

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[1] Manager, Technical Services.

Contributed by the Aviation Division and presented at the Aviation Conference, Los Angeles, Calif., March 12–16, 1961, of The American Society of Mechanical Engineers. Condensed from Paper No. 61—Av-12—"Automation in Random Vibration Testing."

TESTING

By Wayne Tustin,[1]
MB Electronics,
New Haven, Conn.

exciters for further testing on the ground. Here's the background on random vibration testing.

vibration testing must be replaced with a different language. Terms such as band width, acceleration density, root-mean-square or mean-square acceleration, peak-to-RMS ratio, and so on, must be learned. Generally, these are statistical terms; they are used to describe statistically conditions found in random-vibration measurement and random-vibration testing. Item 1 in the Bibliography gives an excellent discussion of these terms and their meanings.

Sinusoidal-Vibration Testing

Fig. 5 shows a cross-sectional view of a typical electrodynamic vibration exciter. Direct current flowing in the field coils causes magnetic flux to exist in the body, an iron casting. A circular gap in the iron body is provided. Flux, radial in direction, crosses the gap. In the gap is located a moving coil that carries alternating current. This alternating current generates alternating force in the coil. The generated force is a direct function of the current flowing in this coil. Specimens to be tested are attached to the magnesium table.

Fig. 6 shows how the vibration exciter of Fig. 5 is normally connected for sinusoidal-vibration testing. An oscillator is the source of signal voltage. This signal is attenuated by the force control. It then passes to the power amplifier which develops the large amounts of electrical power needed to drive the vibration exciter. A vibration pickup attached to the table or to the specimen gives a signal that is measured with a vibration meter; the operator reads inches of displacement, in./sec of velocity, or in/sec/sec of acceleration on this meter.

The test frequency is selected by tuning the oscillator. The test severity or force is adjusted by varying the signal voltage from the oscillator (before it reaches the amplifier); the "force control" is nothing more than the "volume control" of a radio. The circuit in Fig. 6 would be used when the operator wished to identify resonant frequencies within the specimen; this is sometimes called a "resonant search" or "resonance scan." Fig. 7 shows a typical large amplifier and vibration exciter.

Certain test specifications call for "programmed" testing. A typical specification might say, in effect, "Hold 10g acceleration level; cycle 50 to 500 to 50 cps every 10 min for one hour." Asking a human operator to follow these instructions involves close concentration on four interrelated functions. Operator fatigue and inaccurate testing result.

Automation of sinusoidal vibration testing became available as early as 1954. A typical system is shown in Fig. 8.

A frequency-sweeping mechanism varies the frequency of the sine-wave oscillator between preset limits at a preset rate. A servo control system based on an AGC (automatic gain control) unit compares the actual acceleration with the preset acceleration and takes the appropriate corrective action to hold acceleration constant at, in our example, 10g.

By 1956 nearly all components of airplanes were being vibration tested, using sinusoidal testing techniques.. Testing of prototype components was mandatory; often 100 per cent vibration testing of all components was required.

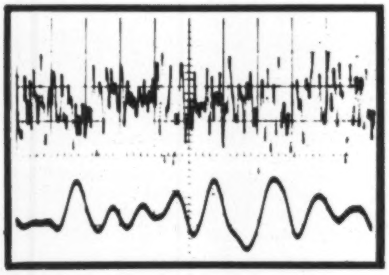


Fig. 4 Unfiltered random signal, and the same signal filtered. The upper signal covers the range from 20 to 2000 cps. The lower trace shows the output of a Krohn-Hite band-pass filter centered on 100 cps with 24 db/octave rejection below and above 100 cps.

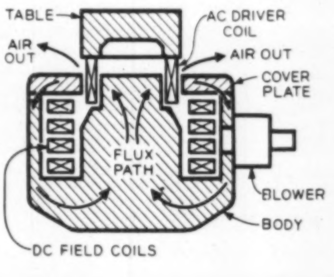


Fig. 5 A typical electrodynamic vibration exciter, on the loud speaker principle. A magnesium table is rigidly attached to the moving coil. The frequency of vibration is exactly that of the alternating current in the moving coil. Specimens are attached to the table.

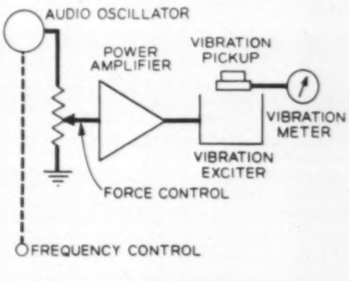


Fig. 6 How the vibration exciter of Fig. 5 is normally connected for sinusoidal vibration testing. A vibration pickup attached to the table or specimen transmits a signal that is measured by a vibration meter.

Random-Vibration Testing

There is much in common between sinusoidal and random-vibration-testing systems. The vibration exciters are identical. Requirements for the power amplifier are more stringent but, granting sufficient power output is available, the same amplifier may be used for random testing as was used for sinusoidal testing. It is in the signal sources, the controls, and the measurement equipment that the differences (and the extra investment) lie.

A Random-Vibration Specification. The reader may be interested in a typical random-vibration-testing specification. A common random specification calls for vibrating a test specimen as follows:

Acceleration density	$0.02g^2$/cps
Frequency range	20 to 2000 cps

Using this example, an engineer would use the formula:

RMS acceleration

$$= (\text{Acceleration density times band width})^{1/2}$$
$$= (0.02) \times (1980) = \sqrt{40} = 6.3g$$

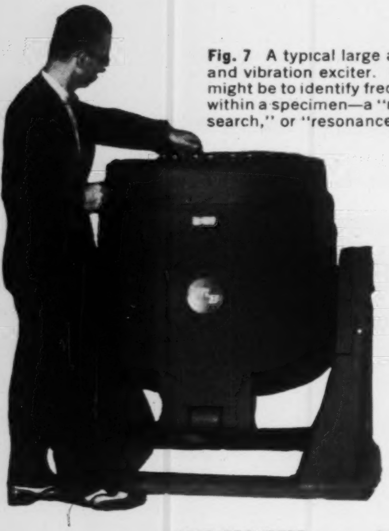


Fig. 7 A typical large amplifier and vibration exciter. One use might be to identify frequencies within a specimen—a "resonant search," or "resonance scan."

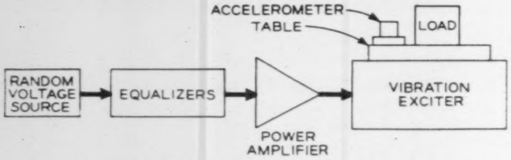


Fig. 8 The specifications for a vibration test may be too much for control by a human operator. Here is automation, using a servo control system based on an AGC (automatic gain control) unit.

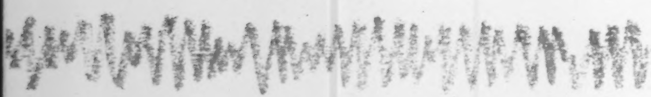
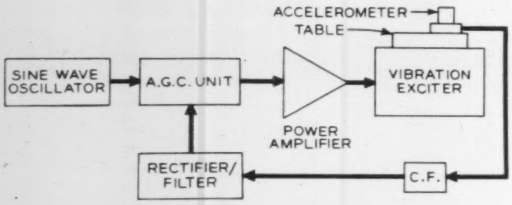


Fig. 9 Random vibration. The random signal passes through one or more "equalizers," through the power amplifier, and finally passes to the vibration exciter, resulting in random vibratory motion of the exciter table and the specimen.



Systems Used. Fig. 9 shows a basic random-vibration-testing system in block diagram form. An accelerometer is usually attached to the exciter table for measurement of the applied vibration. When a random signal is applied to this system, the physical motion of the table and the electrical output of the accelerometer should both be approximately random.

Whatever the exact shape of the frequency response curve, it must be flattened before the random-vibration test commences. Otherwise too much of the random-vibration energy will be concentrated at the peaks and too little will be found at the valleys. This flattening is accomplished by the equalizers indicated in Fig. 9. These equalizers may be likened to complex tone controls that reduce the signal where peaks occur (we may say that at these frequencies the system is mechanically efficient); they add to the signal where valleys occur (we may say that at these frequencies the system is mechanically inefficient). If mechanical resonances in the load complicate the unequalized curve, then the complex tone controls will be more complicated.

Programmed Random-Vibration Testing

In random-vibration tests on rockets and missiles, tests are intended to represent a "typical" portion of the flight as measured during a test flight. During test flights, vibration measurements are made at various points in the airframe; data are telemetered to earth and are recorded on tape for later analysis.

But what is a typical portion? Certainly the vibration level and frequency distribution are markedly different during different phases of the life of the vehicle. The selection of one short typical segment from the telemetered tape, and the use of this segment as the basis for a specification, is at best a great oversimplification.

Some specifications call for different tests to represent these phases. These different tests are run sequentially. Phases of usual interest include: Transportation, ground handling, launch, boost (one or more), glide, and re-entry. Each phase will be different, and the vibration characteristics will change during a phase, as the fuel load is exhausted, as the earth's atmosphere is left behind.

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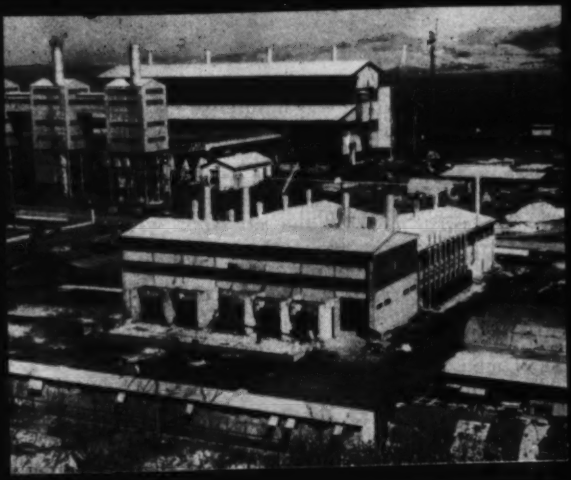

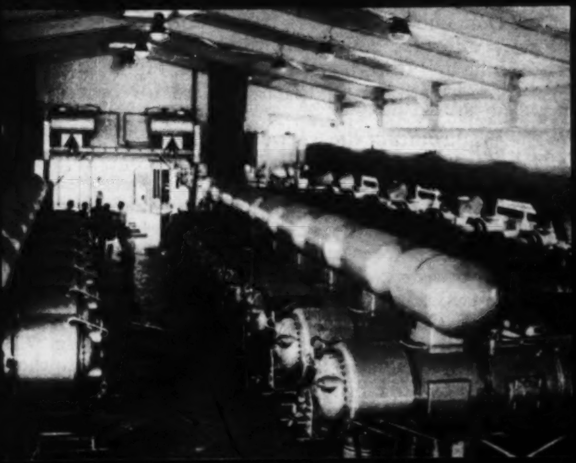

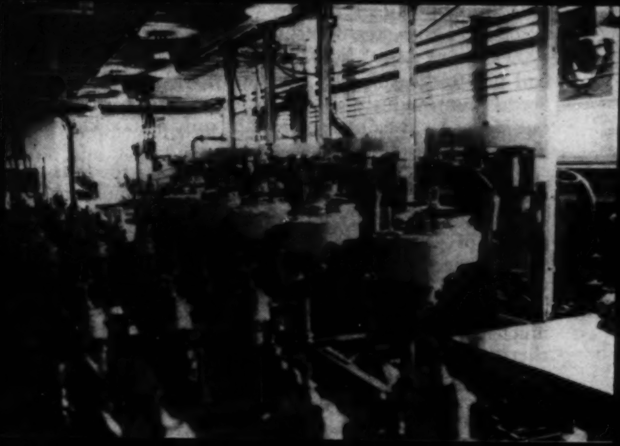

A Free-Piston Power Plant

By M. Barthalon[1]
Assoc. Mem. ASME

Fig. 1 Upper left, Poor foundation conditions, fluctuating demand because of interconnection with a sporadic hydroelectric output, and nearly continuous service demands at other times made a free-piston power plant the ideal source of electricity for an isolated metallurgical plant. Installed for the Societe Le Nickel at Doniambo, near Noumea, New Caledonia, it consists of four 6000-kw units to provide the utmost flexibility.

Fig. 2 Upper right, The turbogenerator room at Doniambo houses the reaction-type 3000-rpm gas turbines, made by Alsthom of France. These contain eight stages and drive Alsthom alternators directly, without intermediate gears. They deliver current at 5500 volts.

Fig. 3 Lower left, There are four banks of SIGMA GS-34 gasifiers in the two center rooms. The two extra machines, in the center, may feed gas to the small 1500-kw free-piston gas turbine used previously in the old thermal station, and now installed in the turbogenerator room.

Fig. 4 Lower right, Each 6000-kw set has its own auxiliaries in this room and other auxiliaries that are common to the four groups (see Table 2).

To serve electric furnaces in a remote part of the world, where flexibility, easy erection, and heavy fuel were factors, they chose the free-piston engine, four banks of SIGMA GS-34's. Intake silencers are part of the system.

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[1] Chief Engineer, Societe Industrielle Generale de Mecanique Appliquee, Paris, France; professor at E. C. L. and CNAM, Lyon.

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Table 1 Sigma GS-34 Characteristics

Engine-cylinder diameter	340 mm (13.4 in.)
Compressor-cylinder diameter	900 mm (35.5 in.)
Maximum possible stroke of moving parts	550 mm (21.7 in.)
Minimum stroke under normal operating conditions	400 mm (15.75 in.)
Maximum stroke under normal operating conditions	500 mm (19.7 in.)
Cycles per minute	350 to 600
Maximum gas pressure	3.6 kg/cm^2 (49.9 psig)
Maximum gas temperature	480 C (895 F)
Maximum gas delivery	4 kg/sec (8.8 lb/sec)
Weight	8 tons

In 1959, when four new electric furnaces for ferronickel-alloy production were added to the large metallurgical plant which Société Le Nickel of New Caledonia operates at Noumea, additional electricity was needed. Three steam turbines with a total output of 4000 kw and a 1500-kw free-piston unit installed in 1957 had previously sufficed. An additional 50,000 kw were needed continuously except for occasional periods when one furnace was being repaired and only 40,000 kw would be required.

Although a 76,000-kva hydroelectric station was then being commissioned 40 miles from Noumea, the irregularity of rainfall within a year as well as over a period of years made a supplementary thermal power station necessary. Normally 100 million kwhr per year would be produced by the thermal station and 300 million by the hydroplant, although in dry years as much as 200 million kwhr might be required of the thermal station. The thermal plant would also be stopped frequently and unpredictably for short periods whenever rain fell, and no long period for complete overhaul could safely be expected.

A steam power station was out of the question, mainly because of lack of flexibility, high cost of operation, and the long erection time. A single 24,000-kw steam set would not offer sufficient guarantee of availability and part-load performance would be poor. Two 12,000 or four 6000-kw sets would have had still higher cost and poorer fuel consumption at full load. Furthermore, a steam plant would probably suffer from the frequent stops that would be demanded.

A diesel installation was unsuitable because it would have required excavation to a depth of 75 ft to establish foundations on the highly compressible mud which was below sea level and impregnated with salt water. Shipment of heavy replacement parts from France would have required months, and no labor with extensive diesel training was available locally. Higher priced fuel would be needed and one standby and one spare engine would be necessary, increasing first cost by 50 per cent.

Free-piston engines had none of these disadvantages and four 6000-kw units were ordered for installation at Doniambo, near Noumea, without any preliminary engineering design, in October, 1958. In March, 1960, less than 14 months from the beginning of foundation excavations, all four units had been started up.

Description of the Station

The Doniambo station, Fig. 1, comprises four different rooms. The first houses the turbogenerators, Fig. 2. The second and third house the gasifiers, Fig. 3, and the last contains all the auxiliaries needed for operation, Fig. 4.

The gas turbines of the reaction type, made by Alsthom of France, have a speed of 3000 rpm and contain eight stages. They drive Alsthom alternators directly without any intermediate gears, Fig. 2, delivering current at 5500 volts. One of the alternators has been built as a synchronous compensator in order to improve cos φ whenever the thermal groups are stopped.

In the two center rooms, Fig. 3, there are four banks of SIGMA GS-34 gasifiers, whose characteristics are reasonably well known by now [1],[2] Table 1, Fig. 7. The two extra machines in the center may feed gas to the small 1500-kw free-piston gas turbine used previously in the old thermal station, and now installed in the turbogenerator room.

The 30-in. gas manifold is designed to be free to expand from a fixed end near the turbine. Gasifiers, as well as turbine, are connected to the manifold through flexible pipes, each incorporating three bellows capable of rotational movement and maintained by universal joints.

Each 6000-kw set has its own group of auxiliaries, while others are common to the four groups, Table 2,

Table 2 Auxiliaries

Auxiliaries for each group	Maker	Model	Capacity	Hp	Rpm
Fuel pump	Mouvex		2000 liters per hr (528.4 gal per hr)	0.75	
Gas-oil pump	Mouvex		2000 liters per hr (528.4 gal per hr)	0.75	
Oil pump	Guinard	H 180 with screw	183 m^3/hr (42,080 cfm)	76.5	
Water pump	Guinard	L 4450-25	320 m^3/hr (75,342 cfm)	38	
Inlet filters	Tunzini-AAF	C.E.M. motor	4 kg/sec (8.8 lb per sec)	0.25	
Auxiliaries common to the four groups					
1 Centrifuge for gas, oil, and fuel	Sharpless	DHM			6440
5 Centrifuges	Sharpless	N. 16		3.5	15000
1 Moving centrifuge		N. 16	4000 liters per hr		
1 Boiler	Field de Poray	TN 52	1200 kg/hr (steam) (2646 lb per hr)		
2 Sea-water pumps	Berger	Height 21 m	700 m^3/hr (164,808 cfm)	85	1450
2 Air compressors (80 kg per sq cm, 1138 psi)	Luchard	M 80 special	118 m^3/hr (27,780 cfm)	43	480

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[2] Numbers in brackets designate References at end of paper.

and Fig. 4. The intake silencers are very simple and effective. They utilize a resonator having a natural frequency well below that of the gasifier. It operates like an acoustic filter dampening the fundamental as well as the harmonics of intake-air pulsation.

Characteristics of Operation. A number of figures are given in relation to power output in Fig. 5. Most important are: (*a*) A heavy instantaneous fuel consumption at full load of 255 grams per kwhr (about 9 oz) at the alternator terminals; (*b*) a consumption of auxiliaries of about 2 per cent of the net power output; (*c*) the possibility of stopping and maintaining each individual gasifier without decreasing the power output of the turbine concerned; (*d*) no effort whatsoever has been made to improve fuel consumption below one-third load, since the individual set will always be operated at full load, or close to full load.

First 2000 Hr of Operation. As usual, in a free-piston-engine installation, as well as in diesel engine installations, the fuel used during the first two months was marine diesel, in order to allow the staff to get used to the machinery without being disturbed by operation of the heavy-fuel system. Also during the first month of operation the power output of each group was limited to 5000 kw in order to avoid overloading whenever stopping an individual gasifier for 500-hr and 1000-hr guarantee inspection checks.

The only major problem encountered during this period was the failure of one of the universal joints controlling the motion and expansion of the exhaust pipe, between gasifiers and gas turbine. This was due to underdimensioning of the parts concerned and was easily corrected. It resulted in a one-week stoppage of the first 6000-kw unit commissioned.

On the gasifiers themselves, four minor troubles were recorded during the same period: (*a*) Failure of eight piston rings (out of a total of 170 in the 34 cyl) which was presumably due to overstressing during factory assembly or faulty breaking-in procedure; (*b*) failure of one out of 10 fuel-injection pipes from imperfect clamping; (*c*) systematic failure of flexible pipes connecting cooling-oil outlets of gasifiers with oil collectors—this was corrected by changing the design; (*d*) failure of a certain number of bolts between compressor cylinder and engine case from faulty manufacturing and assembling.

These minor troubles did not interfere with the overall operation, thanks to the possibility of stopping and maintaining each unit independently. Because rainfall was only one third of normal in the 1959–1960 winter season, the thermal plant was expected to operate almost

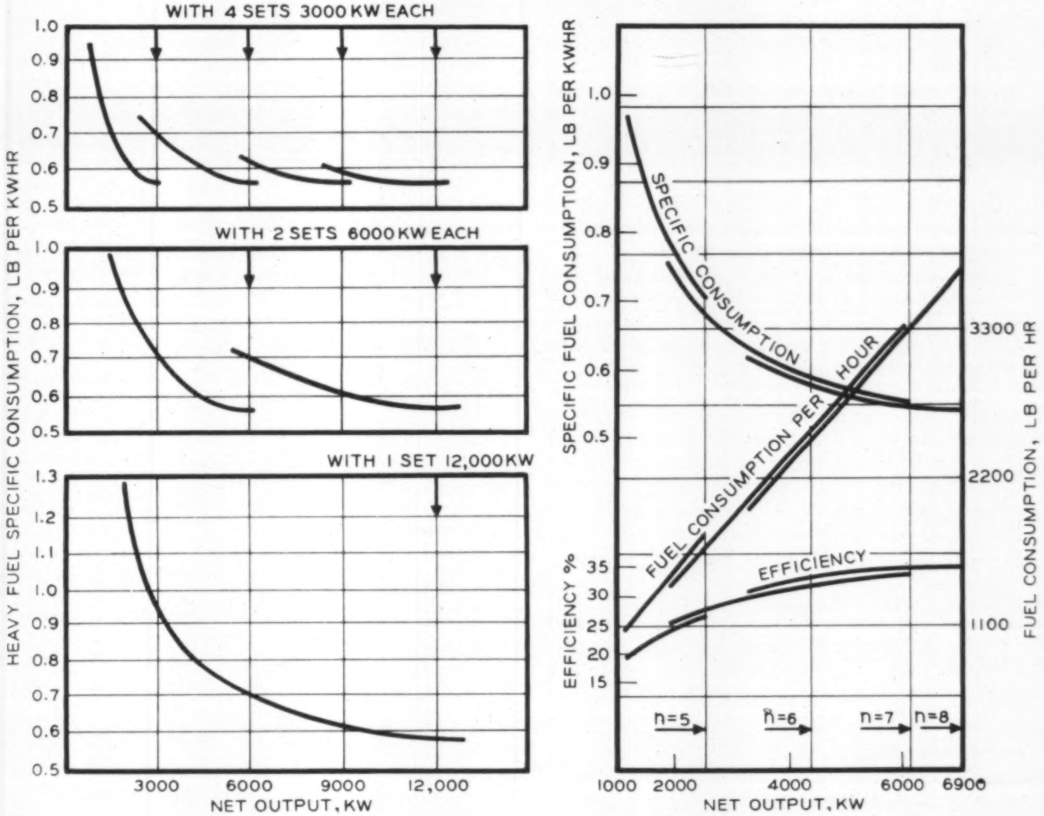

Fig. 5 Characteristics of free-piston-engine operation. Curves give the heavy-fuel specific consumption of a 12,000-kw power station based on a varying number of sets. The graph shows the measured efficiency and consumption of a 6000-kw power set in terms of the power at the alternator terminals and of the number of gasifiers.

Table 3 Heavy Fuel Characteristics

Density to 15 C (59 F)	0.9482
Water	traces
Ashes, per cent by weight	0.03
Sediments per extraction, per cent by weight	0.01
Asphalt contents, per cent by weight	1.92
Conradson residue, per cent by weight	7.48
Sulfur, per cent by weight	2.31
Viscosity, at 25 C, centistokes	305
at 50 C, centistokes	77.8
Flash point, deg F	158
Lower heating value, cal per kg	10,300
(Btu per lb)	(18,540 Btu per lb)

Table 4 Ring and Wearband Wear[a]

	Ring No. 1		Wearband	
Gasifier	Exhaust	Scavenge	Exhaust	Scavenge
J	0.07 (0.0027559)	0.05 (0.0019685)	0.05 (0.0019685)	0.1 (0.003937)
A	0.17 (0.0066929)	0.15 (0.0059055)	0.05 (0.0019685)	0.05 (0.0019685)
B	0.10 (0.003937)	0.05 (0.0019685)	0.05 (0.0019685)	0.1 (0.003937)
E	0.10 (0.003937)	0.07 (0.0027559)	0.05 (0.0019685)	0.05 (0.0019685)
G	0.07 (0.0027559)	0.05 (0.0059055)	0.08 (0.0031496)	0.08 (0.0031496)

[a] After 2000 hr of operation, including 650 hr with heavy fuel—in mm per 1000 hr with inch equivalents in parentheses.

Table 5 Maintenance Schedule

Intervals between inspection	Parts inspected	Time taken for inspection	Number of man-hours
1,000	Fuel nozzles	2	4
7,500	Moving parts	4	12
7,500	Glands	8	32
40,000	Engine cylinder	40	132
40,000	General inspection (the engine cylinder not included)	40	120

Wear observed	
Engine cylinder (exhaust and scavenge cylinder liners)	0.005 mm/1000 hr (0.002165 in. per 1000 hr)
First piston ring (exhaust and scavenge ends)	0.070 mm/1000 hr (0.002756 in. per 1000 hr)
Other piston rings	0.040 mm/1000 hr (0.001565 in. per 1000 hr)
Mean life of components	
Fuel nozzles	5,000 hr
Top engine piston rings	7,500 hr
Other rings and glands	12,000 hr
Injection-pump components	20,000 hr
Exhaust and scavenge engine-cylinder liners	40,000 hr
Synchronizing rods guiding tubes	40,000 hr
Inlet and discharge valves	40,000 hr
Compressor rings	40,000 hr
Compressor cylinders	100,000 hr

continuously in 1960. Since being put into service, the sets have been stopped only for short periods where enough hydropower was available because of heavy rains. (By Feb. 1, 1961, the power station had delivered 138,000,000 kwhr.)

The average weekly operating power is roughly 5600 kw per set, corresponding to a 95 per cent load factor, with power output very nearly constant and varying only when one of the electric furnaces is partly or fully shut off.

The average over-all fuel consumption in industrial service, measured over a number of one-week periods, was found to be 272 grams per kwhr (about 9.6 oz).

The ability of free-piston gasifiers to accept any kind of fuel has allowed Le Nickel to obtain very low cost fuel, Table 3. The lubrication oil was Mobiloil C with Mobilgard 593 specified for engine-cylinder lubrication. Oil consumption was 2.2 grams per kwhr (about 0.078 oz).

Wear measurements made on five gasifiers at the end of 2000 hr of operation, Table 4, permitted the establishment of a rather conservative maintenance schedule, Table 5. Experience with other SIGMA free-piston sets operating under similar circumstances has shown that piston-ring wear stabilizes at half the rate of the first 2000 hr of operation and leads to piston-ring life of 6000 to 12,000 hr [2].

Operating Cost. Operation requires five men per shift: one supervisor, one man in the turbine room, two in the gasifier room, and one in the auxiliaries room. Actual results obtained since commissioning demonstrate that the savings in cost subsidize fuel, lubricating oil, staff, maintenance, and financial charges.

The Free-Piston Industry

Doniambo is but one of 80 free-piston installations totaling more than 500,000 hp in service or under construction throughout the world, Fig. 6. It is truly representative of the speed of development of this relatively new industry and has benefited from the experience gained in 1,500,000 hr of operation under every climate, operating condition, and type of staff [3]. Numerous other applications have been developed, including pipeline pumping stations [4].

Further progress is to be expected shortly [5]. Single-shaft groups up to 24,000 kw have been designed, which represent a marked reduction in the size of building necessary. Over-all investment cost for these is as low as $110 per kw (foundations, building, electrical, and mechanical equipment). A comparison between the Doniambo installation and the new single-shaft units is particularly striking. Remote control of gasifiers on the new units limits the operating staff to only two persons. Furthermore, it takes advantage of the twin-cylinder model SIGMA GS-2-34, Fig. 8, developed in the last two years. This has almost every part found on the SIGMA GS-34, Fig. 7.

The moving parts are phased 180 deg apart with a number of advantages: (*a*) Reduced compressor work (6 per cent less) results in lower delivery temperatures (17 C or 62.6 F less); (*b*) there is a 10 per cent increase in rated output; (*c*) intake and exhaust-damping volumes are much smaller.

Acknowledgment

Thanks are due to SEME and SIGMA of France, for permission to present this material. The author is deeply indebted to R. Huber, technical manager of SEME, who has been the guiding spirit of free-piston design in France for 37 years.

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Table 6 Cost per Kwhr[a]

Fuel	In U. S. mills
Heavy fuel	3.90
Gas-oil (for starting)	0.32
Salaries	1.04
Lubricating oils	0.54
Workship and maintenance	0.32
Financial charges	2.20
Total cost	8.32

[a] For the first part of 1960, on the basis of reception tests for fuel and oil consumption.

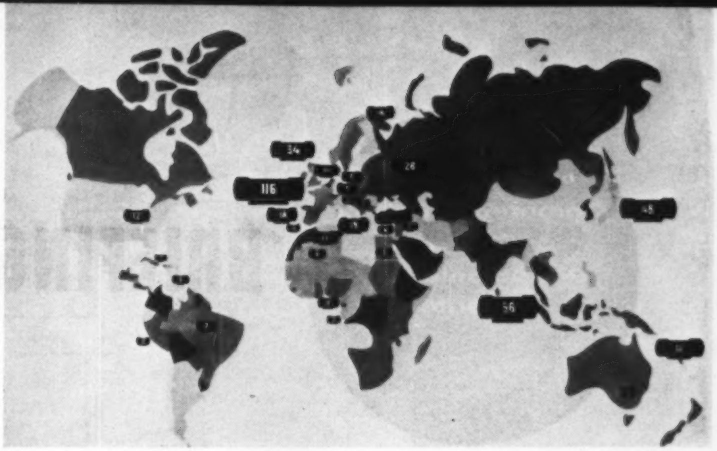


Fig. 6 Free-piston engines of the world, showing the number installed in various countries.

A Free-Piston Power Plant

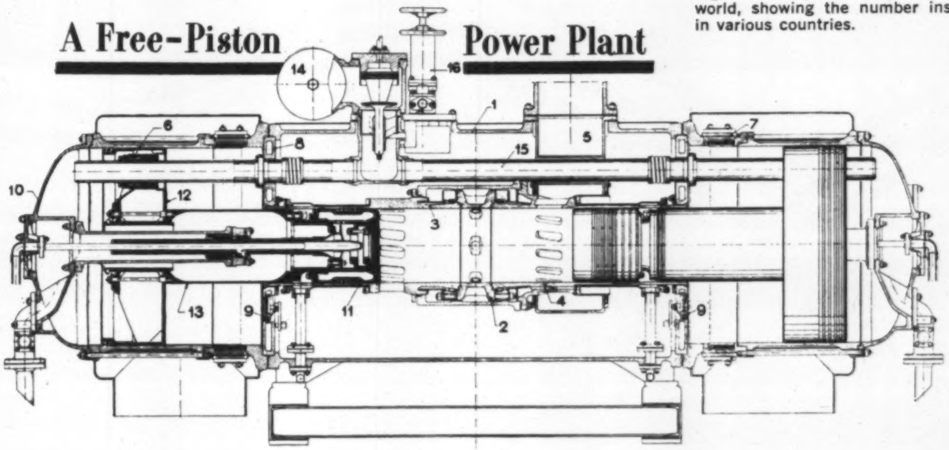


Fig. 7 Cross section of the GS-34 free-piston gas generator: **1** engine case, **2** central ring of engine cylinder, **3** engine cylinder, scavenge end, **4** engine cylinder, exhaust end, **5** exhaust belt, **6** compressor cylinder, **7** suction valves, **8** compressor head plates (with delivery valves), **9** delivery valves **10** cushion head, **11** engine piston, **12** compressor piston, **13** piston trunk, **14** starting-air vessel, **15** balance pipe, **16** stabilizer.

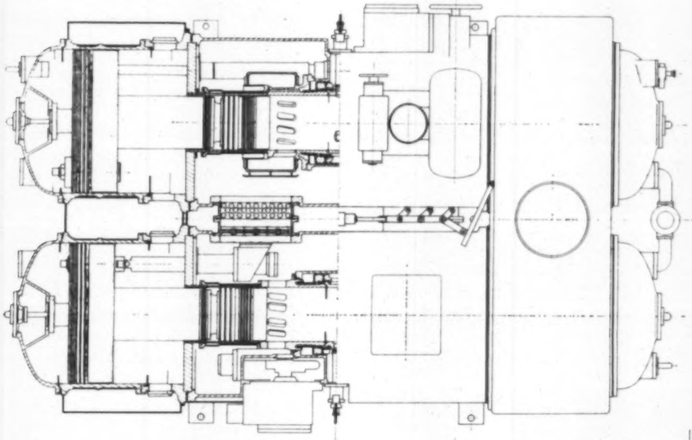
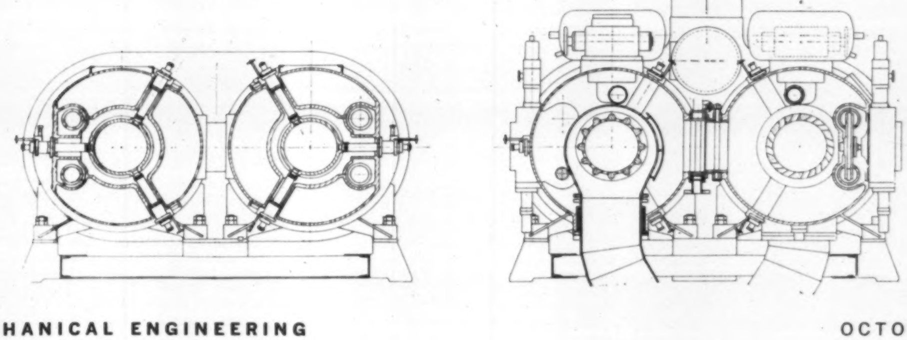


Fig. 8 The twin-cylinder model SIGMA GS-2-34 gas generator has almost every part found on the GS-34. The moving parts are phased 180 deg apart with a number of advantages: **(a)** Reduced compressor work (6 per cent less) results in lower delivery temperature (17 C or 62.6 F less); **(b)** there is a 10 per cent increase in rated output; **(c)** intake and exhaust-damping volumes are much smaller.



Abstracts and
Comments Based
on Current
Periodicals and
Events

BRIEFING THE RECORD

Programmed Tube Bender

Here is another application of a numerically controlled tool—a tube-bending machine.

Fluid-carrying tubes, especially in missiles and aircraft, usually have a very complex shape because they have to be formed to clear various objects. Many times the shape of these tubes is so complex that they cannot be made from engineering drawings. For this reason, most tubes are produced in prototype form on a "bend-as-you-go" basis.

With the tape-controlled tube bender, the work is simplified. First, a piece of soft tubing has to be hand fit to the various recesses and passages it must travel.

Then, when the machine gets this model, it automatically measures the various twists and bends. As the machine makes the first copy of the model, it punches a tape that can be used again and again to make as many parts as needed—all exactly like the prototype.

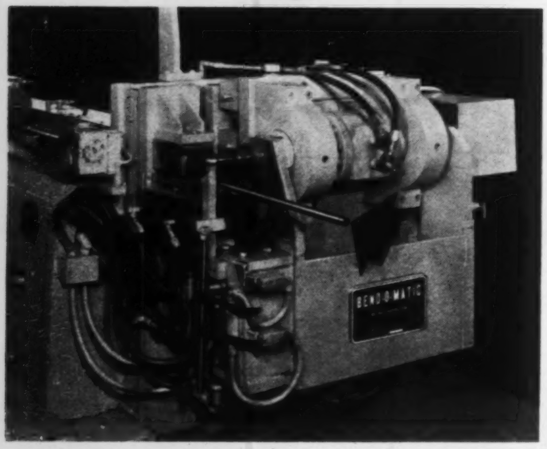
The machine handles tubes up to $1^1/_4$ in. in diam and up to 8 ft in length. It can make angles from one-twentieth of a degree up to 189 deg, depending on the tooling. The maximum bending radius is 3 in., and distance between the bends can be as short as five-thousandths of an in.

– MACHINE SPECIFICATIONS –	
CAPACITY:	Up to 1¼" Dia. Tube — 96" Max. Length
BENDING RANGE:	0-185° — 3" Max. Bending Radius
BENDING TORQUE:	13,200 in-lbs Max. at 1000 P.S.I. Pump Pressure
HYDRAULIC POWER UNITS:	One 10 GPM Pump 1000 P.S.I. Max., Driven by 7½ HP-1800 RPM Electric Motor Two 5 GPM Pumps 1000 P.S.I. Max., Driven by 7½ HP-1800 RPM Electric Motor
MACHINE OPERATION:	Load & Unload by Hand — Operator Programs Bends, Machine Produces Punched Tape with First Part, Next Parts Produced Automatically with Original Tape
FLOOR SPACE:	8'-0" Wide x 22'-6" Long x 7'-0" High

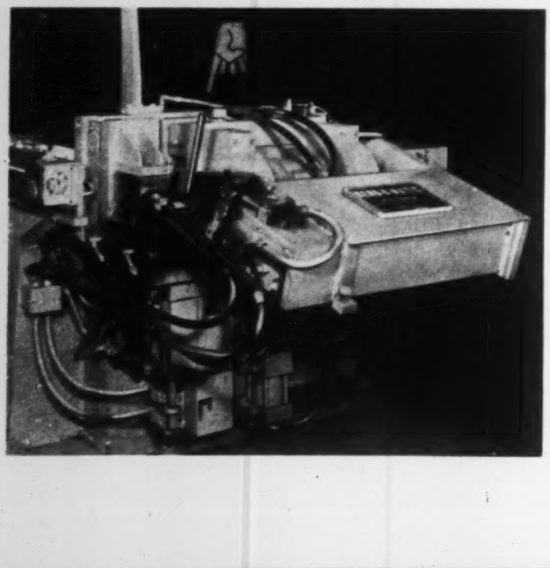
The Bend-O-Matic has three numerically controlled motions: First, tube advance or feed, called the X-motion. This controls the distance between the bends. In the X-motion, the main slide is driven at about 150 ipm by a lead screw.

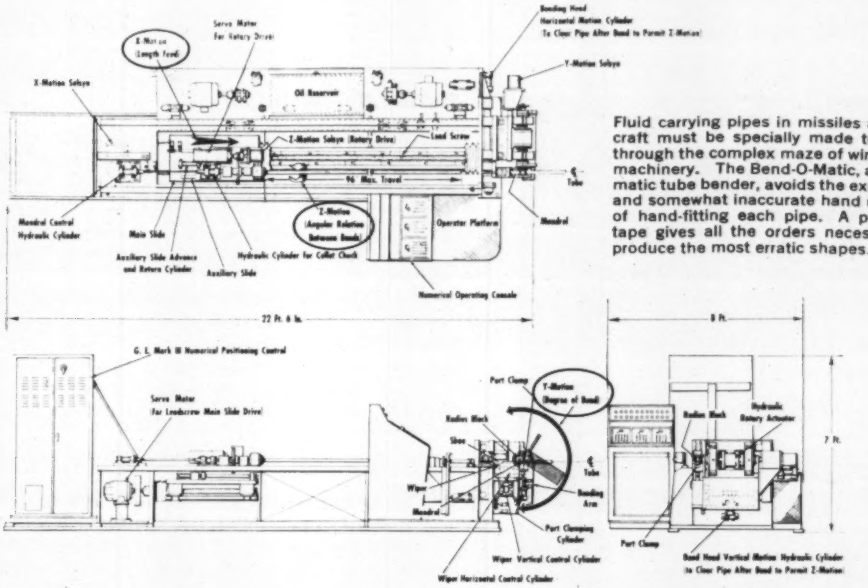
Next, Y-motion, the actual bending of the tube. Y-motion is done with a bending arm that is moved through a prescribed arc by a hydraulic rotary actuator.

Z-motion controls the angular relationship, or the amount of twist, between the bends.



A GE III numerical position control sends commands to position a tube in three planes. In the **top** photo, the tube is being positioned in the X-direction. The Y-axis head bends the tube to the programmed angle in the **bottom** photo. If necessary, the Z-plane will rotate the tube to align it for the next bend. The machine takes tubes up to 8 ft long and $1^1/_4$ in. in diam. Angles can be made from $^1/_{20}$ of a degree up to 189 deg. Distance between bends can be as short as 0.005 in.




Servo Motor For Rotary Drive
X-Motion (Length Feed)
X-Motion Selsyn
Bending Head Horizontal Motion Cylinder To Clear Pipe After Bend to Permit Z-Motion
Y-Motion Selsyn
Oil Reservoir
Z-Motion Selsyn (Rotary Drive)
Lead Screw
96" Max. Travel
Tube
Mandrel Control Hydraulic Cylinder
Main Slide
Auxiliary Slide Advance and Return Cylinder
Auxiliary Slide
Hydraulic Cylinder for Collet Chuck
Z-Motion (Angular Relation Between Bends)
Operator Platform
Mandrel
Numerical Operating Console
22 Ft. 6 In.
8 Ft.
G. E. Mark III Numerical Positioning Control
Servo Motor (For Leadscrew Main Slide Drive)
Part Clamp
Y-Motion (Degree of Bend)
Radius Block
Shoe
Wiper
Mandrel
Tube
Bending Arm
Part Clamping Cylinder
Wiper Vertical Control Cylinder
Wiper Horizontal Control Cylinder
Radius Block
Hydraulic Rotary Actuator
7 Ft.
Part Clamp
Bend Head Vertical Motion Hydraulic Cylinder to Clear Pipe After Bend to Permit Z-Motion

Fluid carrying pipes in missiles and aircraft must be specially made to travel through the complex maze of wiring and machinery. The Bend-O-Matic, an automatic tube bender, avoids the expensive and somewhat inaccurate hand method of hand-fitting each pipe. A punched tape gives all the orders necessary to produce the most erratic shapes.

In operation, the tube is first positioned in the X-direction, and clamped into place. Then, the bending arm moves the tube a predetermined angle in the Y-plane to create the bend. In the following steps, the tube is unclamped and advanced to the position of the next bend. If the bends are not in line with each other, the Z-motion servo takes over and rotates the tube to the proper position in the Z-plane.

One of the big advantages of this machine is the reduction in setup time. This is an important point in short-run production and replacement part manufacturing. Complete changeover from production of one bending pattern to another can be made in 35 min for the average setup.

Color From the Past

Color photography is a hundred years old this year; in 1861, Clerk Maxwell gave the first public demonstration of a color photograph before the Royal Society. Today, amateurs spend around a billion dollars a year on photography, and about one third of that amount is for color slides, snapshots, and movies.

According to an article in the July issue of the Arthur D. Little, Inc., *Industrial Bulletin*, photography is now the most popular hobby in this country; more than 52 million Americans take pictures, and about one million do their own developing and printing.

During the early part of 1861, Maxwell gave a series of lectures on colorimetry, and on May 17 he demonstrated a projected image of a brightly colored ribbon pinned on a piece of velvet. Working under Maxwell's direction, Thomas Sutton, a well-known portrait photographer of the period, had taken separate photographs of the ribbon on wet collodion plates. Each picture was taken through a different colored filter; lantern slides were made from the negatives; and each was projected through a correspondingly colored filter. The three positives recombined on the screen to give the color sensation which had been recorded in the color separation negatives.

During the next 30 to 40 years, however, great progress was made in speeding up the photographic emulsion, and dyes which increase sensitivity to green, yellow, and red were discovered.

As early as 1862, Louis Ducos du Hauron had filed with the French Academy descriptions of three methods of color photography. They were far in advance of their time, and really not practical until the turn of the century. Before 1890, interest in color photography centered on the use of three-color separations, recombined either by simultaneous projection or through ingenious lens and prism devices called photochromoscopes.

In 1891, in connection with his research on interference phenomena, Gabriel Lippmann displayed the first color photographs taken on a single support rather than with a number of separation negatives. The exposure times required were unduly long, however (100,000 to 10 million times greater than those needed today); viewing conditions were limited; and a mirror of liquid mercury was needed inside the camera. For these reasons, Lippmann's process has remained an elegant curiosity.

Between 1895 and 1935, most commercial still color photography involved the use of screen plates embodying a pattern of very fine red, green, and blue filter areas smaller than the eye can resolve. When a color photograph is taken through such a plate, three-color separations are, in effect, made concurrently; the resulting photograph is a collection of different-colored dots which the eye blends into a whole picture.

In 1895 Professor Joly of Dublin made the first screen plates available commercially; from then on, a number of different firms produced them, and they remained in common use up to 1957.

The next major step forward was taken in 1913, when Rudolph Fischer patented a process covering the formation of dye images in the emulsion during the development of the film, followed by removal of the silver image. When used with a film consisting of layers of emulsion and suitable filters, the process results in three simultaneous coextensive color separations; from these are produced three superimposed dye images on a single support. The process was a commercial failure at the time, but it was the important forerunner of today's successful color photography techniques. The first of these was Kodachrome, developed in 1935. Agfacolor Neue, Anscocolor, and many others followed. Thus out of many years of research has come essentially one process (Fischer's) which underlies all the commercial color films and papers available today.

All the drapes and towels used in this operating room are made of disposable Kaycel, an inexpensive material made from du Pont nylon and cellulose wadding.

Throw-Away Fabrics

THROWING things away, some hospitals are finding, is actually a means of saving money. By using disposable drapes and towels in surgery and obstetrics, they cut down on laundering expenses and minimize the possibility of contamination.

This is but one of a string of uses for "Kaycel" material, a nonwoven fabric that is sturdy and inexpensive. Kaycel is marketed by Kimberly-Stevens Corp., New York City, a jointly owned subsidiary of Kimberly-Clark Corp., Neenah, Wis. (paper), and J. P. Stevens & Co., New York City (textiles).

The material, which is described in the July/August issue of the *Dupont Magazine*, is made of a very open netting or "scrim" of du Pont nylon. This netting is then bonded between two layers of cellulose wadding to produce a soft fabric with seersuckerlike dimples. It can be used where strength must be equal to woven fabrics.

Kaycel can be easily dyed or printed, made fire retardant, and water repellent. It can be cut and sewn by standard textile methods. Prices range from 8 to 17 cents a yard.

Among the most popular items made with Kaycel are coats, aprons, and suits for industrial workers. Wearers include chemists, painters, and men who work with radioactive materials. "Throwaway suits are cool, comfortable, and considerably less expensive than having clothing cleaned in a special 'atomic laundry,'" a nuclear equipment manufacturer reports. The Army Quartermaster Corps has run full field trials on such items as fatigue clothes, tents, sleeping bags, hospital gowns, pillowcases, and underclothing made of Kaycel.

The material also is adaptable to several types of coatings, such as latex and polyethylene, which suggest specialty packaging applications.

Radiation Research Lab

A NEW high-intensity radiation development laboratory is now under construction at Brookhaven National Laboratory, Upton, N. Y. The laboratory will study the effects of nuclear radiation on such things as foodstuffs, packaging materials, rubber products, and chemicals. Other projects will explore possible economic uses for radioactive wastes from nuclear reactor fuel elements. Through this research may come a solution to the storage and disposal problem confronting the U. S. Atomic Energy Commission.

Experimental work is scheduled to begin at the laboratory in July, 1962. At the outset, high-intensity radiation will be provided by 50,000 curies of Cobalt 60, now in the storage site. Later, the amount will be doubled.

Because of the high radiation levels, adequate shielding is a must. Concrete walls will be 6 ft, 4 in. thick in some areas. Entrances will have thick lead doors, and high-density lead glass windows with lead shutters.

Burns and Roe, Inc., New York City engineering and construction firm, has been awarded the construction contract. They are responsible for repairing the site plan and designing the buildings.

Robot Paints Storage Tanks

ENGINEERS of the Esso Research and Engineering Co. have built a robot that looks like a small army tank. It will automatically prepare and paint any relatively smooth metal surface both vertically and horizontally.

A preliminary model has been built and successfully tested. Chief potential applications appear to be large metal storage tanks and ships' hulls and decks.

The front of the tank has a chipping tool that prepares the surface; a pressurized roller at the rear applies the paint. Magnets, set onto the treads, keep the painter stuck to the surfaces. Direction is decided by an operator using pneumatic controls.

The Esso engineers estimate that four such robots—about three ft long and one and one-half ft wide—could paint a medium sized tanker in 16 man-days, compared with 200 man-days manually.

The cost of painting such a ship by regular manual methods averages as high as $20,000 for protection that sometimes lasts only two months. If the robots can be perfected, the same job could be done for between $7500 and $14,000, and would last up to two years.

The model is simulating the work to be done by a new robot painting-machine. The actual robot will be a tanklike vehicle with magnets in its treads. It will be able to crawl up the sides of a ship or a storage tank, painting as it goes.

F-1 Engine Tested

The F-1 rocket engine, with a 1.5-million-lb thrust, is being developed for the National Aeronautics and Space Administration by Rocketdyne, division of North American Aviation, Inc.

The first use of the F-1 may be in an advanced Saturn C-1 booster. Two F-1's may be paired for a lift-off thrust of 3 million lb. The first test launch of the C-1 booster is scheduled for later this year.

Although the F-1 has been under development by the NASA for two and a half years, earliest feasibility studies on a million-lb-thrust single-chamber engine dates back to 1955. The first complete engine test was made on June 13, 1961, at Edwards, Calif. About one million lb of thrust were generated at that time. Now the F-1 is undergoing a test series that will build up to its full force of 1.5 million lb.

The basic designs and same propellants used in the F-1 are also used in the Atlas, Thor, Jupiter, and Saturn vehicles. These rockets have launched 43 of the nation's 47 successful satellites and space probes.

The F-1 rocket is now undergoing a series of tests that will build its thrust up to a full 1.5 million lb. When ready, the engine may be used as an advanced Saturn booster.

Project Chariot Report

The Atomic Energy Commission has published a first summary report on Project Chariot which is part of the Commission's Plowshare program to investigate the use of nuclear explosives for peaceful purposes. In this instance, the experiment will be an excavation in the Ogotoruk Creek area of northwestern Alaska.

Over 30 surveys were made during 1960–1961 to provide facts about the plant and animal life in the area. This information will be related to the available radiation effects data from the Nevada Test Site and the Pacific Proving Grounds for a preliminary estimate on the possible biological effect of conducting the experiment. After this and future information is combined and studied, a final decision will be made on the feasibility of a safe nuclear explosion at Ogotoruk Creek.

The Commission will approve this experiment only if there is assurance that it will not jeopardize the local inhabitants or the plant and animal species from which they derive their livelihood. Final authorization for use of nuclear explosives will come from the President.

Some of the problems involved include the possible elimination of species, reduction of food chain links, and elimination or dispersal of populations of plants and animals essential to the Eskimo.

The problem of the Eskimo's mobility must also be considered since he is dependent on the area for food, shelter, and clothing. Hunting and fishing conditions along with possible water contamination must be evaluated before planning the blast.

Should the explosion take place, there will be at least three areas of environmental disturbances, largely confined to the lower reaches of the Ogotoruk Creek and the area at its mouth. These are:

1 Redeposition of about 30 million cu yd of debris.

2 Possible local shore current modifications with the filling of the basin with sea water.

3 Venting of radioactive materials and deposition on land and sea.

Maximum depth of debris at the crater's edge is expected to be about 100 ft, diminishing to an average of around $^1/_2$ in. at a radial distance of 1 mile from ground zero. Existing habitats and their plant and animal population will be totally destroyed in the area surrounding the crater. Modification of habitats will lessen from the area surrounding the crater and should be nonexistent beyond the limits of throwout.

Detecting Spring Flaws

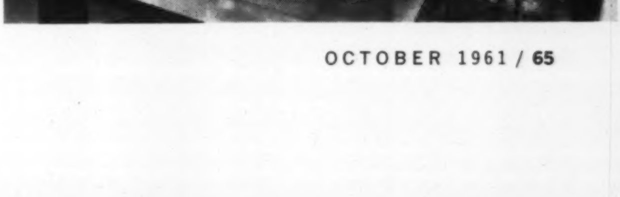
Associated Spring Corporation has a new method of inspecting spring wire. This device finds the flaw, records the fault on tape, then paints the defective area so it can be easily found and discarded later.

Normally, wire gets only a visual inspection before it is made into springs. However, the new system, working at high speed, can pick out minute flaws anywhere on or near the surface of the wire. Nicks, pits, and seams are eliminated before they can cause trouble.

In operation, the wire passes through a magnetic field set up by a coil. The field maintains some predetermined pattern as long as the wire passing through it is flawless. But, any nick or crack in the wire causes a variation in the field that is picked up by a pair of sensing coils. The variation which is changed to an electric signal triggers the marking system. A spray gun coats the deformed segment as it passes the painting station. Later in the production process the deformed wire is discarded.

All flaws are recorded on tape for a permanent record. This tape can be used later to certify the wire's quality.

Engineers at Associated Spring Corp. have installed an electronic detector that uses a magnetic field to find flaws in spring wire. The tunnel-like structure on the **left** is a demagnetizer, and a pair of sensing coils are on the **right**.

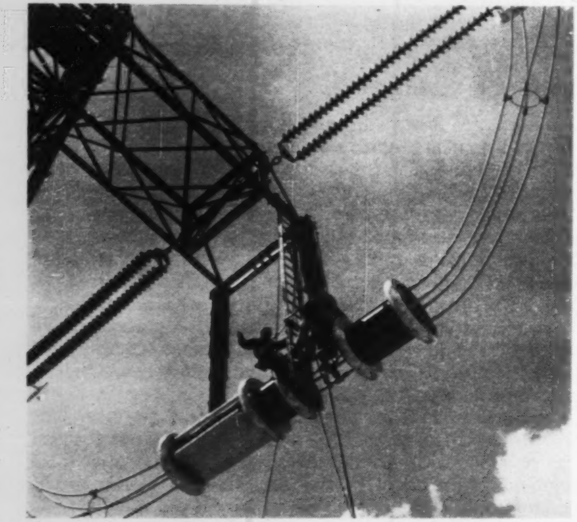


750-Kv Power Transmission

An extra-high voltage test transmission line at Apple Grove, W. Va., was energized at 775,000 volts, marking the start of a five-year research and test program. Its purpose will be to develop the information and experience needed to transmit large blocks of power at voltages up to 750 kv. This is more than twice the operating voltage of commercial systems in this country today.

Prime objective on the project is to obtain data on corona loss and radio influence (RI) performance of conductors at a nominal voltage of 750 kv. The project, which was announced last spring, is cosponsored by American Power Service Corporation and Westinghouse Electric Corporation.

As to the physical layout of the test site, power goes from a 138-kv tap through a disconnect switch to the 138/750-kv auto-transformer, then to a 750-kv bus structure. Three 2400-ft-long three-phase lines, which originate at the substation bus, form a "T" shape. A control and instrument house is in the 138-kv switchyard near the load-break switch and auto-transformer. The test line connects to a tap from a double-circuit line between South Point, Ohio, and the Philip Sporn plant at Graham Station, W. Va.



Linemen are preparing to connect the lead from the coupling capacitor between two chokes. This is one of the decouplers for isolating the three lines for radio influence measurement.

Calculations to select the best conductor size for 750-kv operation were based on experience at other high-voltage projects. The three-phase lines use bundled conductors—four separate conductors on 18-in. centers for each phase.

Simultaneous independent RI readings can be taken on each of the three lines. Decouplers (blocking filters) for radio interference frequencies, installed between the lines, minimize the interaction of the radio noise. This permits independent measurement of RI on each of the three line sections.

To prevent condensation on the line it is necessary to keep the conductor slightly above ambient temperature. To produce current for this heating, the four conductors in each phase bundle are insulated from each other and connected in series. This arrangmenet keeps the conductors warm, as in normal use, with a minimum drain on the power system. The heating current circulated is equivalent to about a 1,000,000-kva load on each line.

The tests will be completely instrumented, using magnetic tape data logging equipment. Effects of various atmospheric conditions will be assimilated into data for proper statistical analysis. Readings taken will include: temperature, relative humidity, air pressure, wind direction and velocity, radio influence, corona-loss, and air contamination.

Fuel Cells[1]

Because fuel cells have a high energy-conversion efficiency, they are among the most promising devices for generating electric energy from chemical fuels. Essentially, fuel cells are primary batteries, where the "fuel" is fed continuously instead of being consumed in batches. Fuel cells are electrochemical devices that produce electrical energy directly from chemical energy. Since they are not limited by Carnot-cycle efficiency, fuel cells may easily produce twice the electrical energy of a heat engine burning the same quantity of fuel.

The first reference to fuel cells dates back to 1839, so it is not a new idea. By 1890, the concept of the fuel cell was clearly understood, but most work leading to practical devices has been done in the past 30 years. Now the annual budget for research and development of fuel cells may exceed $30 million.

Although some potential civilian uses have been demonstrated publicly, such as a fuel-cell-powered tractor in 1959, much more attention has been directed to military applications. Mainly, these cover situations where conventional primary batteries are not suitable because of short life, or where an engine-driven generator is too heavy or too noisy. Another interesting property of fuel cells is that, in some designs, the cell may work backward as an electrolysis cell to produce hydrogen and oxygen from water. These gases can be stored outside the cell and later recombined in the same cell to return a large fraction of the electrical energy consumed during electrolysis. Hence an energy-storage system can be built in little space and with moderately good efficiency. Such systems are being studied for satellites where silicon solar cells would produce electrical energy while in sunlight, with conversion of part of this energy to hydrogen and oxygen. When in the earth's shadow, the fuel cell would convert this hydrogen and oxygen back into electrical energy, thereby providing a continuously available source of electricity to the satellite's instruments and radio equipment.

Low-temperature fuel cells. Most advanced of all the fuel-cell systems today are those based on hydrogen and oxygen. Because of its simplicity and reasonable output it has received more attention than the other types. The electrodes are porous and serve as a reacting surface separating the hydrogen and oxygen, and the electrolyte (30 per cent KOH solution.) Oxygen, diffusing through the porous cathode, reacts with water in the electrolyte to form OH^- with electrons transferred from the electrode. This OH^-, in turn, reacts with hydrogen at the anode to form water, in this case, transferring electrons to the electrode. Hence there is a potential developed and current flows in the external circuit.

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[1] This article was condensed from a paper titled "Electric Power Sources of the Future," by William T. Reid and A. P. Edson. It was prepared for The International Nickel Company Power Conference held in Estes Park, Colo., August 1–4, 1961.

High-temperature fuel cells. Another type of fuel cell uses molten carbonates as electrolyte and operates at temperatures from 750 to 1300 F. Such high-temperature fuel cells can utilize carbonaceous fuels because of the increased reactivity at the higher temperature and because the removal of carbon dioxide from the alkaline aqueous electrolyte is no longer a problem.

One such cell, built by Broers and Ketelaar, can operate at temperatures as high as 1300 F. The electrolyte in this cell is a mixture of lithium, sodium, and potassium carbonates, immobilized in a porous sintered disk of magnesium oxide. This arrangement provides a good ionic conductor without the problem of handling a free molten salt.

On each side of this disk are powdered-metal compacts, silver on the cathode side and nickel or platinum on the anode side. These are the "reactive" surfaces. Both are backed up with wire gauze that is in turn in contact with perforated stainless-steel plates. The plates serve as the anode and cathode connections. Mica gaskets seal the internal parts of the cell and asbestos gaskets are placed outside the electrodes. Stainless-steel end pieces surround the entire system, with suitable bolts compressing the assembly to prevent leakage.

Performance of such cells is only fair as yet. With hydrogen, the output potential at 100 amp per sq ft is only 0.4 volt, and at 150 amp per sq ft it is but slightly more than 0.1 volt. With carbon monoxide the voltage is only 0.2 volt at 40 amp per sq ft.

Thermal efficiency of the fuel cell, defined here as the ratio of the change in free energy to the change in enthalpy, approaches 94 per cent at room temperature. However, as the operating temperature rises, the difference between the free energy of the reaction and the heat of the reaction increases so that the over-all thermal efficiency falls. This places a practical upper limit on the operating temperature of fuel cells compared with heat engines. As a result, the high-temperature cell appears relatively less attractive than the low-temperature cell from the efficiency standpoint, as well as operating simplicity and convenience. However, as noted before, until a practical means is devised for fueling low-temperature cells with hydrocarbons, there will be considerable interest in high-temperature fuel cells.

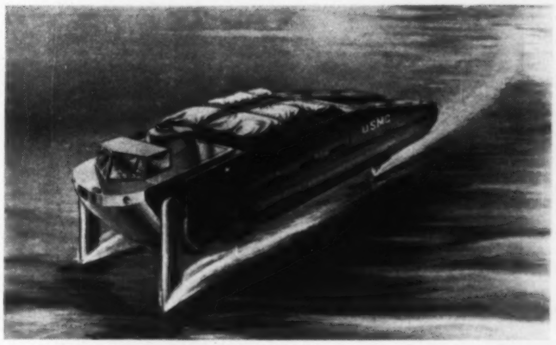
Kitchen Utensil Solves Atom-Age Problem

You have heard plenty about how "modern science helps solve the housewife's problems." Now, the housewife has responded in kind. From her supply of pots and pans she has come up with a utensil which has solved an Atomic-Age problem.

Scientists at Aerojet-General Corporation's Nucleonics plant needed a supply of small, watertight containers with lock-on lids to store uranium. They had to be small, because large concentrations of uranium in one container could be dangerous. They had to have lock-on lids to prevent spillage.

As the atomic experts pondered their problem, an ingenious employee-housewife solved it for them with the same exasperating womanly deftness used to restart stalled cars with hairpins.

Her perfect solution—an ordinary "pressure cooker," from the world of the pantry. And, temporarily stalled science rolled on again.



In an amphibious operation, this hydrofoil cargo-carrier will gather material from widely scattered supply ships and carry it to the shore. It can travel as a boat, and on land, as well as on its hydrofoils.

Hydrofoil Landing Craft

The Navy has selected Avco Corporation's Lycoming Division to design and develop an amphibious hydrofoil craft. Its mission will be to pick up cargo from widely scattered supply ships and deliver the material to shore during an amphibious operation.

The craft has the designation LVH, for Landing Force Amphibious Support Vehicle, Hydrofoil. In a landing operation the LVH will "fly" through the rough water, boat through the surf zone, then use its wheels on land.

A Lycoming TF-1430 marine gas-turbine engine will give the craft a flying speed of around 35 knots, a boating speed of several knots, and an overland speed of more than 25 mph. The hydrofoils, one forward and one aft, are completely submerged during all water operation. For land travel, they are retracted entirely within the hull. The foils are self-cleaning and will operate through floating debris without damage.

There are separate propellers for boating and flying operation. The flying propeller is mounted on the bottom of the rear strut. To steer the boat, the entire lower section of the strut, including the foil and propeller, is rotated. A retractable drive beneath the hull carries the boating propeller. For land travel, there are four huge 18:00 × 25:00, 12-ply tubeless tires.

The Lycoming Division has had considerable experience in hydrofoil design through the past years. In 1959, it designed and developed the "Flying Duck" for the Army. It was a gas-turbine-powered conversion of the famed World War II DUKW. Prior to that, they installed a Lycoming T53 in the "Halobates," a modified LCVP, developed by the Navy.

No More Lightships

Steel towers will replace all but two of the Coast Guard's 24 lightships now in use near U. S. shorelines. According to an item in the June, 1961, issue of *Steel Facts*, the new towers will end a 140-year tradition.

The first two towers will be located off the New England coast and are expected to be completed in November. Four 338-ft steel legs will support each tower. The legs will be made of 33-in-diam steel tubes filled with concrete poured around a 12 or 14-in. H-beam core and braced with steel tubular sections. With the legs burrowed 200 ft into the ocean floor, the towers are expected to withstand more than hurricane force. The top of the tower will be 170 ft above sea level.

From this control console, power directors at the Philadelphia Electric Co. supervise the loading of generating units at minimum incremental cost. A digital computer, developed jointly by Minneapolis-Honeywell and the utility, decides which of the 34 units will generate power, and at what rate.

Power Generation Under Computer Control

How do you allocate power generation among the many units of several power stations to meet, at minimum cost, the power demands of a great industrial area?

The Philadelphia Electric Company, serving a population of 3,640,000, in the 2340 square miles of the Delaware Valley, has installed an automatic control system that "tells" 34 generating units (27 units in eight steam stations and seven units in one hydrostation) what share of the company's total requirements each should supply. High-speed analog control elements are joined with a powerful industrial-process computer, the Honeywell 290, to perform the function of assigning generation at minimum cost.

The Minneapolis-Honeywell Regulator Company designed and built the system in collaboration with the utility, and the installation is said to be the first for which all components have been produced by a single manufacturer.

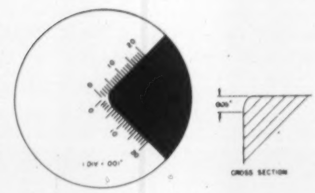
The completely transistorized system has three basic elements: Computer, load-frequency controls, and equipment which joins the two and enables them to "talk" to each other. These components are located in the utility's dispatching center in mid-city Philadelphia.

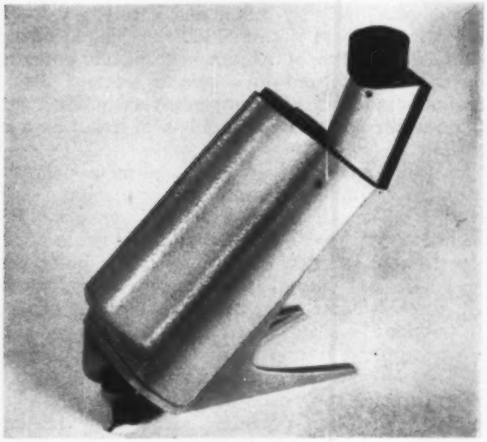
Stored in the computer's memory are hundreds of facts about the system: Efficiencies and production costs of the generators as well as transmission-line loss data. The computer arrives at the most economical allocation of electrical load among the generators. These allocations are then telemetered to each station, where electronic devices "give orders" to each turbine-generator.

Each hour, the computer reads the amount of power being exchanged between Philadelphia Electric and the Pennsylvania-New Jersey-Maryland Interconnection. This integrated power pool ties together the capacity of twelve utilities to effect economies and to insure power to 15 million people. A similar reading is also performed for exchanges of power with Delaware Power and Light Company and Atlantic City Electric Company. After reading power flow on the interconnecting tie lines, the computer makes cost determinations for intercompany billing purposes, and punches the computations on paper tape for accounting use.

The company is not willing to say how much the computer will save, but the system represents an investment of $1 million and is expected to reduce costs.

The Die-Wear Microscope, measures with an accuracy of 0.001 in. The diagram, **right,** is a view through the microscope eyepiece when examining a die edge.





Precision Die Measurement

It is extremely important to maintain precise measurements on metal dies. Since each 0.001 in. of die metal produces a certain number of stampings, the smallest amount ground away unnecessarily reduces the life of the tool.

With the new Die-Wear Microscope from Bausch & Lomb, one look can determine the exact amount of metal that must be ground away to properly resharpen the cutting edge. The microscope is capable of measuring die-wear over a range of 0.020 in. to an accuracy of 0.0005 in. or 10 per cent of the depth, whichever is greater. The instrument also measures bevels, burrs, and fillets.

The lightweight instrument is easily carried to the job. When the operator takes readings, the microscope can be positioned on the die or the base can be removed when it is more convenient to hold the instrument by hand.

A hardened and ground guide at the front of the instrument contacts the die edge to be measured, automatically positioning the microscope for best viewing. The guide fits in holes as small as $^{3}/_{32}$-in. in diam or slots $^{3}/_{16}$ in. wide.

The instrument is battery operated but can use 115 v, 60-cycle current with an accessory transformer.

King-Size Metal Bender

A powerful metal-bending machine has been installed by the Harnischfeger Corporation of Milwaukee. With the touch of a button this press delivers an impressive 2000 tons of pressure. That's enough to shape a section of superstrength alloy steel 26 ft wide and $1^{1}/_{4}$ in. thick with no strain.

The machine covers more than 350 sq ft of floor area, rests in a pit 11 ft below floor level, and extends more than 21 ft into the air.

In one operation the $150,000 press can do the work

A new ceramic thermoelectric generator can convert white-hot temperature directly into usable electricity. A voltmeter shows the generator converting heat from a furnace at 2400 F into 100 volts of electricity.

that formerly required as many as five strokes with conventional machines. As another advantage, the press allows the use of higher grades of alloy steels than normally would be practical.

The press is operated by one man and a helper, even on the heaviest of jobs. Stroke for the press is 24 in., bed is 26 ft. long by $2^1/_2$ ft wide, and operating pressure goes up to 3000 lb per sq in. Power comes from a 200-hp electric motor.

A complex control system permits selection of four different pressing speeds in increments of from 5 to 24 in. per min, depending on the job.

An automatic governing control in the 1000-gal hydraulic system constantly maintains the ram in a level position. If one cylinder lags, the system automatically bleeds oil from the lead cylinder and feeds the lagging cylinder.

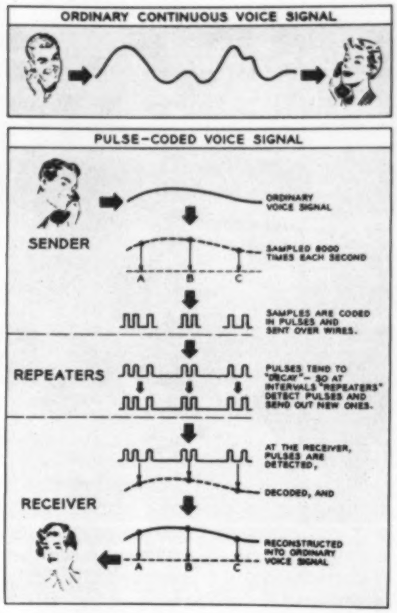
Electricity From Rocket Exhaust

The thermoelectric generator, which converts heat directly into electricity, can now be used for high-temperature operation. The new generator, developed by Minneapolis-Honeywell, is constructed almost entirely of ceramic material. Since it can withstand temperatures up to 2400 F, the unit may provide a way of obtaining electricity from such waste heat as rocket exhausts. Presently available thermoelectric generators would be destroyed at such temperatures. Another use might be to tap the energy of a space-vehicle nose cone as it is superheated by re-entry into the earth's atmosphere.

Output of the new generator is 1000 to 1200 microvolts per deg C, compared with 250 to 300 for intermetallics. The pilot model will deliver 100 volts under no load.

The generator is made like a cake, with 14 layers. The ceramic, nickel oxide, is sprayed on one side of each layer, and platinum, acting as a reference, is sprayed on the other side. A feltlike ceramic separates the layers. Even the nuts and bolts holding the unit together are made of a special ceramic since ordinary steel would melt at the high operating temperature.

A second thermoelectric generator being built by Honeywell also uses nickel oxide. But, this one will substitute iron oxide for the platinum, producing even higher voltages.


ORDINARY CONTINUOUS VOICE SIGNAL
PULSE–CODED VOICE SIGNAL
SENDER
ORDINARY VOICE SIGNAL
SAMPLED 8000 TIMES EACH SECOND
A
B
C
SAMPLES ARE CODED IN PULSES AND SENT OVER WIRES.
REPEATERS
PULSES TEND TO "DECAY"– SO AT INTERVALS "REPEATERS" DETECT PULSES AND SEND OUT NEW ONES.
AT THE RECEIVER, PULSES ARE DETECTED,
DECODED, AND
RECEIVER
RECONSTRUCTED INTO ORDINARY VOICE SIGNAL
A
B
C

The diagram traces the pulse-coded voice signal from sender to receiver. Not shown are the pulses representing the many other voices that would be interlaced and fed over the line at the same time.

Coded Voice Signal

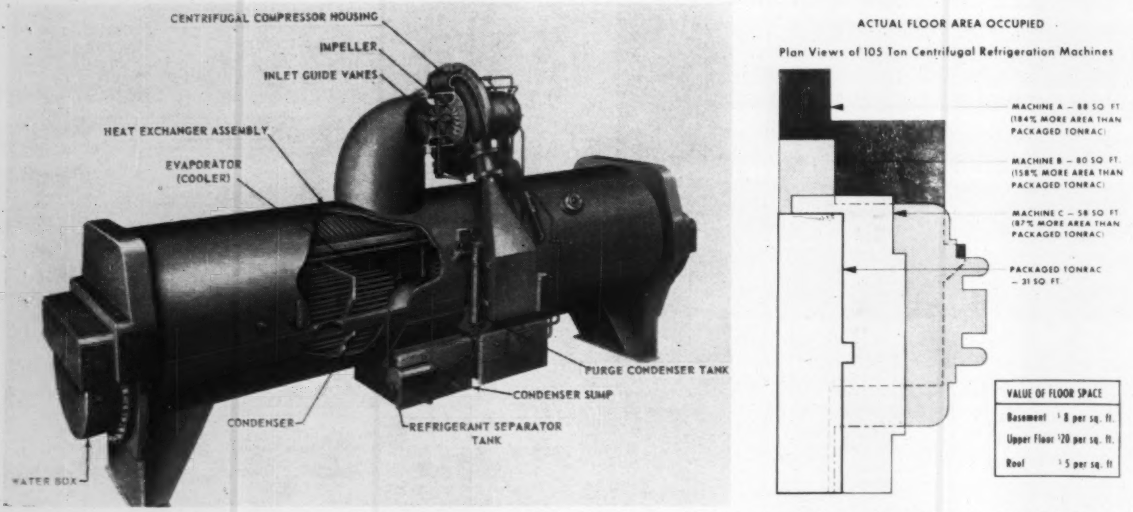
Only a coded signal—not the usual voice signal—goes over the wires in Bell Telephone's new communication system. They call the new principle "pulse code modulation," or simply "PCM." The experimental system (designated T-1), now in operation between Newark and Passaic, N. J., may eventually be used across the country.

Instead of sending a continuous voice signal, the T-1 takes samples of the speaker's voice very rapidly—about 8000 times a sec. These samples are encoded into a series of pulses, and the pulses are sent out over the wires. At intervals of approximately 6000 ft, the coded signals are reconstructed and sent on to the next repeater point. The system sends pulses over the wires so fast—one and one-half million per sec—that the codes of many different voices can be interlaced on the same wires. This property of the new system gives it its biggest advantage—a greater message-carrying capacity. Other systems that permit wires and cables to carry many messages have been used for years by telephone companies, but they have been economically feasible only over fairly long routes. The T-1 was designed to serve metropolitan-area routes of up to 25 miles.

The new system is expected to be particularly useful in large cities such as New York, where congestion below ground has often made it difficult to find room for additional telephone conduits.

The telephone companies will not have to dig up city streets to install T-1. Instead, they can connect terminal equipment in telephone buildings at each end of the route, using existing cable. The repeater equipment will go in manholes or on poles along the way.

The T-1 system will be manufactured later this year for general use throughout the Bell System.


CENTRIFUGAL COMPRESSOR HOUSING
IMPELLER
INLET GUIDE VANES
HEAT EXCHANGER ASSEMBLY
EVAPORATOR (COOLER)
PURGE CONDENSER TANK
CONDENSER SUMP
CONDENSER
REFRIGERANT SEPARATOR TANK
WATER BOX
ACTUAL FLOOR AREA OCCUPIED
Plan Views of 105 Ton Centrifugal Refrigeration Machines
MACHINE A – 88 SQ FT (184% MORE AREA THAN PACKAGED TONRAC)
MACHINE B – 80 SQ FT (158% MORE AREA THAN PACKAGED TONRAC)
MACHINE C – 58 SQ FT (87% MORE AREA THAN PACKAGED TONRAC)
PACKAGED TONRAC – 31 SQ FT
VALUE OF FLOOR SPACE
Basement $8 per sq. ft.
Upper Floor $20 per sq. ft.
Roof $5 per sq. ft

With the connection of just a few pipes and a power supply, the packaged Tonrac is ready to supply chilled water or central air conditioning. American Standard engineers have used a lot of design tricks to keep the refrigeration machine compact. The diagram, **right,** compares the Tonrac with three other machines.

Compact Refrigeration Machine

Engineers at American Standard have come up with a refrigeration machine that takes less floor space and weighs less than most comparable units. This compact unit, called the Packaged Tonrac, comes completely wired, piped, and insulated, and ready to operate with just a few connections.

The Packaged Tonrac will act as the heart of central station air-conditioning systems, providing chilled water for zone or individual room air conditioners in hospitals, schools, small office buildings, and similar structures. It is manufactured in eight size increments from 50 to 100-ton nominal refrigeration capacity.

The packaged design is completely piped at the factory and needs no auxiliary water piping, refrigerant piping, or control tubing installation on the job site. The only piping required on the job is that for the air-conditioning load, and from the cooling tower to the condenser.

Components of the Tonrac unit include a centrifugal compressor with electric drive motor, heat-exchanger section (with condenser and cooler portions), plus necessary piping, valves, and controls. Power comes from a separate motor-generator-exciter power unit which converts 60-cycle line current to 300-cycle current for the Tonrac motor.

The power unit can be located at the most convenient spot and need not be adjacent to the refrigeration machine. The power-unit generator can be operated from any rotary prime mover, an important point in areas where steam or natural gas is less costly than electric power. With this arrangement, steam turbines or internal-combustion engines can act as stand-by power sources.

Because of the compact design, the completely assembled machine will pass through a standard 36-in-wide doorway. No walls need to be knocked out.

Another design feature that helps reduce size and weight is the combination of the condenser and cooler in a common shell or housing. The Tonrac design retains the conventional heat-exchanger elements but puts the cooler on the top and the condenser on the bottom to make one shell serve both portions. The condenser is separated from the cooler by a pair of leak-proof divider plates with a gas space between them to insulate one portion from the other.

The compressor is driven by a new electric motor that uses liquid refrigerant for a coolant. In operation, refrigerant from the condenser sump is admitted into the low-pressure motor housing. Change of state from liquid to vapor at the motor windings permits the refrigerant to absorb all heat generated within the motor.

Because the bearings are cooled by the motors cooling system, there is no need for a separate oil cooler.

The Tonrac needs no auxiliary compressor to handle the purging of foul gases. Instead, it utilizes the pressure differential which always exists between condenser and cooler. This pressure forces all foul gases from the condenser.

Japanese Competition[1]

After years of relative indifference, Americans have suddenly become acutely aware of foreign trade and competition. For the first time in recent history, we have a balance-of-payments problem.

Competition from Japan, more than that from any other country, has been widely recognized as a threat to U. S. industry. There was more opposition only to trade with Soviet Russia. This attitude toward trade with Japan is held despite the fact that we trade less with Japan than with a number of other countries, and also despite the fact that the United States sells more to Japan than we buy in return.

At first glance, Japan's increase in exports to the United States seems ominous and results in cries for action to halt the flood of Japanese products. But when this situation is looked at in proper perspective, it is less evident that a need for drastic action exists. Japan's exports to the United States have increased rapidly—but from a very low base.

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[1] This item was condensed from an article titled "Need We Fear Japanese Competition?" by Stewart H. Rewoldt. It was originally published in the summer, 1961, issue of *Business Horizons*.

Japan has, year in and year out, suffered a deficit in trade with the United States. The United States has recognized Japan's need for removing this deficit and has been, in general, sympathetic to actions taken by Japan toward this end. The problem was made extremely difficult by the heavy dependence of the Japanese economy on imports, particularly imports from the United States. These imports could not be reduced without unfavorable effects upon the Japanese economy. Thus the only available approach was to attempt to increase exports in order to earn the funds necessary for these indispensable imports. The efforts to do this have at last begun to bear fruit.

Why is there so much concern about imports into the United States market from Japan when, in fact, the Japanese have long been better customers for us than we have been for them? Three factors appear to be of primary importance. First, the trend in Japan's exports to the United States has been consistently upward over a long period, while no such upward trend is evident in our exports to Japan. Second, imports from Japan make a big impression on the consumer market and compete directly with American-made goods; this is not true of our exports to Japan. Third, imports from Japan tend to be concentrated in certain product lines and often represent a significant share of sales for these types of products in our market.

Although our trade relations with Japan have in the past been satisfactory, it is possible that our imports will continue to rise while our exports do not keep pace. This imbalance is unlikely to happen in the near future because Japan appears willing to remove restrictions on imports from the United States in order to prevent it.

With Japan so heavily dependent on imports, it follows that a healthy Japanese economy will provide a good market for United States exports. The relationship between our imports from and our exports to Japan is, however, even more direct than this. Some of the products we sell Japan go into products we, in turn, buy back. One of our major imports from Japan is cotton textiles, and Japan is by far America's best customer for raw cotton. We import steel and steel products from Japan, and the United States supplies Japan with from $33^1/_3$ to 50 per cent of the scrap metal and 25 to 30 per cent of the coking coal needed by its iron and steel industry. Thus action to reduce our imports from Japan would directly affect our opportunity to export.

On the basis of a comparison of our exports to and imports from Japan, it is obvious that the U. S. derives substantial benefits from such trade. It is, however, a mistake to reach conclusions about the benefits from trade with Japan on this basis alone; some important political factors must also be considered.

Japan occupies a position of strategic significance in our foreign policy. It is the greatest bulwark of freedom and capitalism in all of Asia; it is one of our most important military bases in the struggle against world communism; it is a showpiece for all the world to see of the effectiveness of free enterprise in economic development. Potentially, it is one of our strongest allies in providing aid and guidance to underdeveloped lands, particularly in Southeast Asia.

From the foregoing evaluation, we can make the following conclusions concerning U. S.-Japanese trade:

- The competitive strength of Japanese industry is increasing in relation to the competitive strength of United States industry. This narrowing of the gap is probably inevitable considering the different levels of maturity of the two economies and the greater ease with which an economy can advance in certain earlier stages.
- It is to the advantage of the United States for Japan to be strong economically. Japan is an important customer for United States products now, and as her economy grows Japan is likely to become an even better customer. The continued economic strength of Japan is also very important from the standpoint of American foreign policy. Japan's economic strength is heavily dependent on its foreign trade and, in turn, the United States market is important to Japan's foreign trade.
- United States industry is still more competitive than the industry of Japan. If our industry rises to the challenge of competition from Japan, it can be expected to hold its stronger position. It has no need of government help for this purpose.
- The United States government should not set up artificial barriers restricting the sale of Japanese goods in the United States market. Rather, it should make our own businessmen aware of the opportunities for sale of United States products, both in Japan and elsewhere. A major assistance to business would be the removal of restrictions that still exist in Japan and other countries on the importation of United States products.

Atomic Barge

The Army Corps of Engineers has ordered a floating nuclear power plant capable of supplying the electrical needs of a community of 20,000. If wartime action or a natural disaster cuts off the power of a coastal town, the "atomic barge" can be towed into position to supply emergency power.

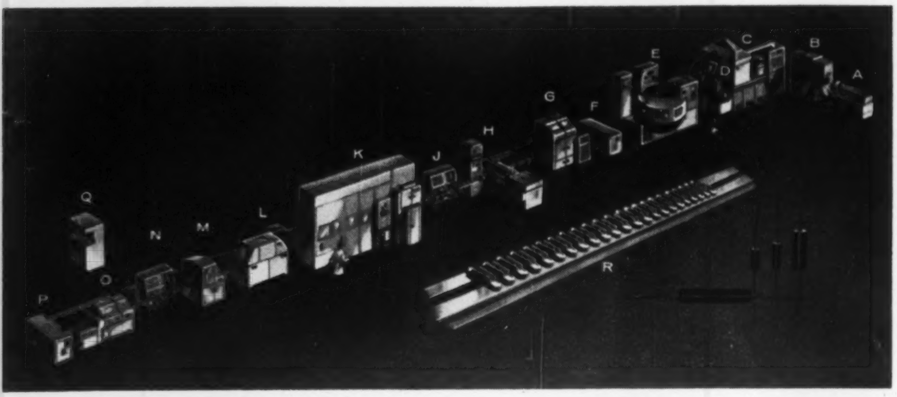
This nuclear power plant will be designed and developed by The Martin Company. The finished plant will be installed in the reconstructed Liberty ship, *Walter F. Perry*.

In contrast with the 110,000 bbl of oil a year needed by a conventional plant of the same size, the 10,000-kw Martin system will use a nuclear fuel core less than four ft in diam and only a little more than three ft high. It will be possible to deliver its periodical fuel charge by air if necessary.

The floating plant, which is called MH-1A (M for "mobile," H for "high power," and 1A indicating that it is the first field plant of its type), will have definite peacetime applications. A hurricane or an earthquake could bring it to the aid of a stricken dockside area.

The reactor planned by Martin is a "pressurized water" system, using techniques which have proved successful and reliable in a number of stationary atomic plants. Water passing under pressure through the hot core of the reactor transfers the heat to water at lower pressure in a separate "secondary loop." The steam produced there turns the blades of a turbine, generating electricity. Power will be transmitted to shore through heavy cables from a tower near the bow of the ship.

At present, the *Walter F. Perry* is still resting in the "mothball fleet" at Jamestown, Va.; but work on it may begin even before Martin completes its final design late next year. Construction and all test phases will require an additional 36 months.



Machine stations for the automated production of carbon resistors.
A, Computer.
B, Output-input control.
C, Coating station.
D, First inspection.
E, Terminating station.
F, Conveyer control.
G, Capping station.
H, Helixing station.
J, Second inspection.
K, Encapsulating station.
L, Leak dector station.
M, Marking station.
N, Third inspection.
O, Packing station.
P, Control equipment.
Q, Cap-lead welder.
R, Detail of conveyer line.

Automated Resistor Production

WESTERN ELECTRIC COMPANY's new automated production line is a completely computer-controlled process for making deposited carbon resistors. The line has 11 stations—all controlled by a general-purpose computer with a 4096-word magnetic memory drum. Nowhere in the production line is the resistor touched by human hands.

Before, individual precision products were made manually or in semiautomatic processes which invited contamination from handling and related shortcomings of human control. Such production methods were impractical where the reliability demanded of the resistors was so great (no more than one failure per 200 million hr of operation).

The computer, which is the heart of the control equipment, performs in three areas:

1 It programs production control. A month's requirements can be fed into it at random. It completely schedules and programs the work, arranging it according to four resistor powers and an almost infinite number of possible resistance values.

2 It analyzes control. Using the methods of statistical quality control, it takes data plotted at three critical points in the automated process and applies statistical tests to determine if a trend is developing. Feedback of process data from these three key points along the line permits rapid closed-loop operation.

3 It formulates the information to detect any drift away from the accepted manufacturing tolerances. No control action takes place while this analysis indicates normal statistical distribution around a desired nominal. But when a trend away from this condition develops, the computer uses stored data to calculate new setup information for the appropriate station.

The process to make a reliable resistor begins initially with a tiny ceramic core, the resistor's nucleus. The first step is to coat this core with a carbon film to give the resistor a certain value. To get this coating, the core travels through a horizontal furnace where methane gas is decomposed to form crystalline carbon on the core.

Three parameters govern the resistance coating value: the speed of the core through the coating zone, the pyrolysis temperature, and the flow of methane gas. The computer controls these parameters through a feedback loop.

After the coating, the core gets its first inspection. If it passes, it goes on to the terminating machine which "sputters" a gold contact over each end. In this operation the core goes to a pickup station to be fitted with a mask, which holds and protects the center of the core. The mask is loaded onto a vacuum station and covered with a bell jar, which is pumped to a vacuum and then backfilled with argon gas. Then the ends or the core protruding from the mask are "sputtered" with particles from a gold cathode. The sputtering lasts for about a minute, depositing a layer of gold approximately ten millionths of an inch thick.

Now the wire leads must be attached. These leads are first welded to tiny hexagonal caps of gold-plated brass by an automatic percussion welding machine which is outside the line. The cap-lead assemblies are then inserted into the capping machine and fed into capping chucks. The resistor core, coming from the terminating machine, is loaded onto a turret which holds it in position while the capping chucks simultaneously press the cap leads over both ends.

The next operation is helixing, where the newly formed resistor obtains a precise value. The helixing machine cuts a spiraled groove along the carbon film of the core to obtain the desired resistance. A computer-controlled bridge monitors the cutting done by rotating the resistor against a diamond-impregnated wheel. The bridge's control servos balance when the desired resistance is reached, disengaging the bridge lathe. The helixing, or spiraling, is done "dry" and continues until final resistor value is reached.

After a second inspection the surviving resistors next feed into an encapsulating machine. Here a precured epoxy shell is fitted over the core and two epoxy pellets are inserted over each end. After a 15-min oven curing, at a temperature of over 300 F, the epoxy forms an effective seal with the shell.

A leak detection test comes next—then on to a marking machine. Here wattage, resistance value, production lot number, and date are stamped on the encapsulated resistor.

There is a third inspection, then finally the resistor moves onto a packing platform where it is pushed into a styrofoam block as part of the packing operation. Each block full of resistors goes down a hopper into a loading magazine.

Now, the completed resistor is ready to begin reliable service in an electronic circuit.

China's Progress

In an effort to estimate Communist China's technical progress, the National Science Foundation sponsored a symposium at which specialists in 25 scientific fields analyzed masses of available Chinese literature and presented their appraisals.

Here are the results as listed in the June, 1961, issue of the *Battelle Technical Review:*

1 China has perhaps fewer than 400 research mathematicians with training equivalent to the doctorate; not more than 1200 at the doctorate level in the natural sciences.

2 The country has upped the total of its geological workers to 21,000 as compared with 200 in 1949. As a result, the country is discovering and exploiting its vast mineral deposits. China is now sixth among steel producers and third in production of coal.

3 Crop-improvement research has been hindered to some extent because the theories of Michurin rather than those of Mendel and Morgan must be followed.

4 Although electric power production has increased by 800 per cent since 1952, 1960 production amounted to only 90 kwhr per capita as compared to 4250 kwhr in the U. S.

How China is faring in its technological manpower problems is discussed in a report by Leo A. Orleans, "Professional Manpower and Education in Communist China." His analysis points out that the quality of present college graduates is usually low, and those trained in the West and the USSR are the core of China's professional manpower. Educational methods suitable to the country's situation are being employed. The educational base of the masses is being raised and the number going into professional training is rising about 10 per cent each year.

China's current pool of people with higher education is put at about 625,000 by the author. His breakdown: 171,000 in engineering, 134,700 in education, 70,000 in finance and economics. According to present estimates, annual additions to this pool include about 18,000 engineers, 30,000 in education, 5000 in health fields, and 4600 in science.

Gamma-Ray Research Mineral

The Bureau of Mines, Department of the Interior, plans to build an atomic-research facility at Albany, Ore., for studying minerals and mineral fuels.

The new structure, scheduled for completion in the next 12 months, will house 100,000 curies of cobalt-60, supplied by the Atomic Energy Commission. This radioactive isotope will be used to determine the effects of gamma radiation on the physical and chemical properties of coal, petroleum, and many metallic and nonmetallic minerals.

Gamma irradiation may help advance mineral technology, either by altering the properties of minerals and fuels so they can be processed more easily or by actually speeding chemical reactions in mineral-treating processes. Small-scale studies have indicated that both approaches are promising.

The gamma-ray source at Albany will consist of 24 strips of radioactive cobalt, each doubly sealed in capsules of stainless steel and aluminum. When not in use, they will be stored under 17 ft of water in a deep well. When needed, the capsules will be raised into a cell-like structure with 4-ft-thick walls of heavy-density concrete.

Viewing windows made of leaded glass and remote-controlled manipulators will let scientists conduct experiments without the risk of high-level radiation exposure. Although such radiation will be present inside the cell, materials removed from the cell will have no residual radioactivity. This fact, plus the incorporation of safety features in the design and the use of proper methods during operation, makes the plant safe from the standpoint of potential radiation hazard, according to the Bureau of Mines director.

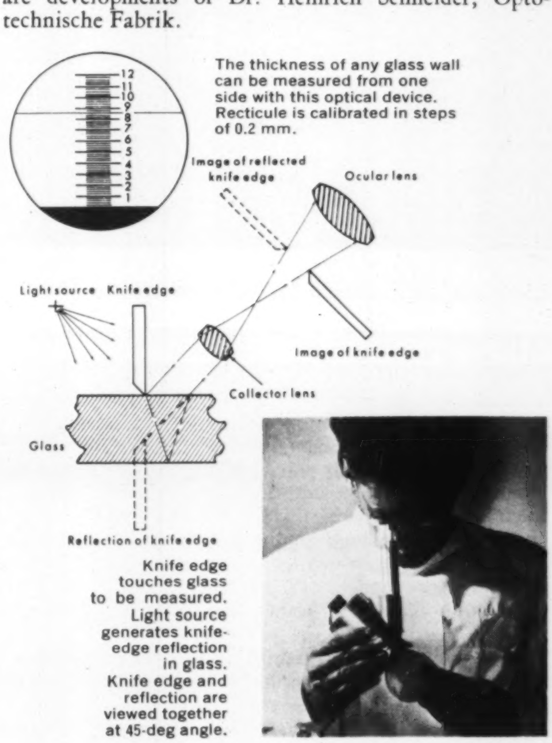
Shadow Shows Glass Thickness

From Germany comes a device that uses an optical trick to measure the thickness of glass. This small meter makes the measurement from one side of the glass by using the reflection of a knife edge. A simple lens system has a fixed edge set at 45 deg. The distance between the edge and its image is directly proportional to wall thickness.

The description of the meter which appears in the June 5, 1961, issue of *Design News* goes on to explain how continuous measurements can be made. A black shadow of the edge projection always remains at the zero mark of the measuring reticule, and the thickness registers as a thin line on the scale. The line's position on the scale moves with variations in the thickness of the glass. The meter can check any transparent material.

The device is especially helpful in measuring irregular shapes or objects such as light bulbs where you don't have access to both sides of the material.

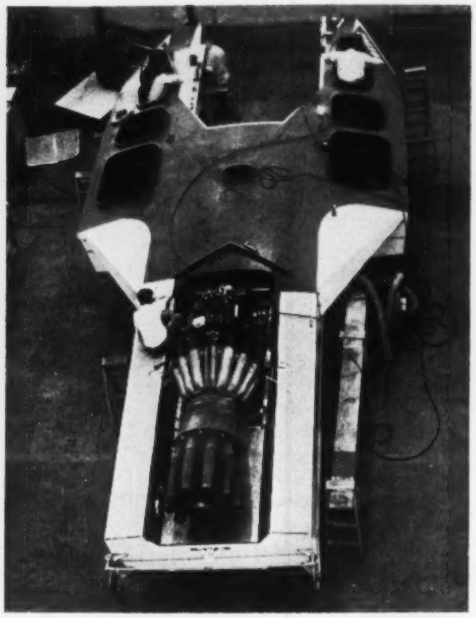
Standard meter version ranges from 0.2 to 12 mm with plus or minus 0.1-mm accuracy; smaller versions cover the 0 to 1.2-mm range with 0.01-mm accuracy. Both are developments of Dr. Heinrich Schneider, Optotechnische Fabrik.



The thickness of any glass wall can be measured from one side with this optical device. Recticule is calibrated in steps of 0.2 mm.

Knife edge touches glass to be measured. Light source generates knife-edge reflection in glass. Knife edge and reflection are viewed together at 45-deg angle.

This official U. S. Navy photo shows one of the two new test facilities at the David Taylor Model Basin. The model is drawn through the water while wave-making machines simulate conditions at sea. By observing the model, the behavior of the actual vessel can be accurately predicted.



Various hydrofoil models will be tested at high speed in this boat. There is no propeller; propulsion comes directly from a modified jet engine. The cockpits in the front of the boat are for the driver and test observer. Models being

Boats and Basins for Hydrodynamic Research

Although most people are thinking of missiles and superjets as the only way to travel, there is a lot of renewed interest in one of man's earliest modes of transportation—by water. Fast submarines and hydrofoil craft that literally fly through the water are two projects which may make the waterways competitive in this day of high-speed travel.

The following two items illustrate the growing interest in water travel. In both instances new research facilities have been built to study hydrodynamic models with one purpose—to enable man to move through the water faster and more efficiently.

Navy Opens Indoor Ocean. The Navy recently opened its new research facilities at the David Taylor Model Test Basin. A large building covering about five acres houses the new facilities which consist of a "seakeeping" basin and a "rotating-arm" basin.

At these large pools or basins various conditions a vessel would actually encounter at sea can be accurately reproduced. By observing a model moving through these artificial seas, engineers can determine its "seakeeping ability" or seaworthiness. From the actions of the model they can predict the behavior of the full-sized vessel and can solve complex control problems. Each of these new basins is designed to investigate specific hydrodynamic characteristics and produce different sea conditions to bring out certain performance features in the model.

Through these new basins, the Navy will be better able to accurately predict performance in realistic seas and to solve complex stability and control problems. Formerly, these predictions had been somewhat idealized since the basins then in use could not produce conditions actually encountered in rough sea. The new basins can, however, simulate both variable and confused seas which more nearly resemble the actual ocean conditions. Models can be run at any angle to the waves and execute maneuvers that test the handling qualities of the ship.

The maneuvering and seakeeping basin is the largest simulated ocean in the world, according to Navy sources. Ship-model tests conducted here are concerned with the loss of sea speed, the improvement of seakeeping characteristics, and prediction of ship's motion in rough water.

Pneumatic wave-makers located on adjacent walls of the basin can simulate the entire range of ocean environment up to seas corresponding to gale force winds. Fixed bar-type wave adsorbers on opposite walls reduce reflections from generated waves to a minimum.

Ship models are towed through the water from a bridge which spans the basin's entire length. A controlled model-towing carriage runs on tracks under the bridge. Trolley wires supply power to the carriage.

The rectangular concrete basin is 240 ft wide by 360 ft long. Water depth is 20 ft except for one section where it is 50 ft deep. Its capacity is 12,000,000 gal.

The rotating arm basin is the second of these facilities. Its purpose is to provide the basic hydrodynamic coefficients required to solve the complex problems associated with these test vehicles. Model tests conducted here are concerned with the directional stability, maneuverability, and control of high-speed submarines, torpedoes, and surface ships.

The rotating arm radially spans the circular basin and supports the test models. The arm pivots on a bearing in the center of the basin and is driven by a pair of electric motors directly coupled to two wheels which support the arm and run on an outer peripheral rail.

The basin is 21 ft deep and 260 ft in diameter. It holds about 8,000,000 gal of water.

tested extend into the water from the structure between the plows. The observer can vary the model's position and record its behavior characteristics under various conditions.

Jet-Boat Tests Foil Designs. Ordinarily, hydrodynamic model testing is done in huge tanks or basins where the model can be pulled through the water under special controlled conditions. Boeing is extending this technique by creating a jet-propelled floating laboratory that will draw models of hydrofoils and advanced vehicle through the water at speeds up to 100 knots.

The Aqua-Jet, as the craft is called, is lobster-shaped with two prows or "claws." Each prow contains a cockpit; the port cockpit has the boat operator and the test observer is in the starboard cockpit.

Hydrodynamic models are mounted on a controllable fixture between the prows. As the Aqua-Jet speeds through the water, the test observer can vary the position of the model and observe the results on his instruments. All tests are conducted in quiet water with the runs lasting about one minute.

The test boat is 38 ft long with a 17-ft beam. Power comes from a single Allison J 33 jet engine mounted on the aft hull. There is no underwater propeller. Cost of the boat is around $25,000.

One of the first tasks for the jet boat will be to test designs for a "supercavitating" hydrofoil. (A hydrofoil is a wing which "flies" just under the surface of the water.) The foils on most existing craft are subcavitating. This means they have been designed to operate with a smooth flow of water over the foil surfaces, both top and bottom. As the foil's speed through the water increases, pressure on the upper surface decreases. This reduction of pressure on the upper surface, compared with the lower surface, produces the lifting force just as in aircraft flight. After reaching sufficient speed, the lifting force on the "wing" or foil raises the hull completely out of the water, thereby decreasing greatly the water resistance to forward motion.

However, when the pressure on the upper surface drops too far, a vapor cavity forms. The result is loss of lift and increased drag. This phenomenon is referred to as cavitation and at present imposes a speed restriction on hydrofoil craft. Some experimental work has indicated the possibility of designing a foil which would operate at "supercavitating" speeds with a stable vapor cavity above a large portion of the foil's surface.

Harnessing the Tides

For as long as man has been aware of the rise and fall of the tides, he has dreamed of one day harnessing their power. Now, French engineers hope to do just that with their River Rance project, presently under construction. It may prove an efficient and economical way to provide power from the sea.

The July issue of *Consulting Engineer* describes the project's basic design. The mouth of the River Rance estuary will be dammed. As the tides rise, water will flow in through turbines in the dam wall; when the tides fall, water flows from the dam through the turbines once again, back to the sea. In each case the fall of water is utilized to produce electricity.

The predominant advantage of the Rance project will be its ability to provide power when it is needed at peak consumption periods. In other installations, water mills have been devised to make some use of tidal currents. But the tides have an intermittent action and will not ebb and flow at man's convenience. The times when such tidal stations can develop power seldom coincide with the times when power is needed most. However, the operators of the Rance project can predict the tides accurately and correlate this with the pattern of expected peak demand. Water will be stored on one side of the dam during slack periods and let out as needed.

The dam will stretch one-half mile across the estuary with the power station built right into the dam. Other sections of the dam will contain sluice gates, a lock for navigation, and provision for additional power units. There will be 24 turbine units, each producing 10 megawatts. The projected maximum station potential of 240 megawatts compares favorably with the largest conventional hydroelectric power stations.

The turbines used will have to comply with some unique specifications:

Turbine action must be efficient, regardless of the difference in water level on opposite sides of the dam. (The station will operate at a head varying from 3 to 40 ft.)

Turbine action must be reversible. (The station must be operable with flow in either direction.)

Turbogenerator units must be reversible so they can be used to pump water behind the storage dam in slack periods.

Water flow through the unit must be free when the turbine is stopped.

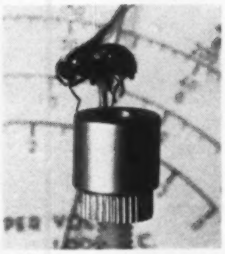
The project is being carried out for Electricité de France, the nationalized French electric company. Plans call for a yearly production of 625 million kwhr of current by 1966. The estimate for the project in 1960 was $78 million, but the present budget includes provision for additional cost increases.

The first turbines will not be installed until 1964, and, if works goes as scheduled, the station will begin feeding power into the French national grid sometime in 1966.

PHOTO BRIEFS

M. BARRANGON

1 **PRESSURE TRANSDUCER.** Mirax Chemical Products Corporation, St. Louis, Mo., makes this crystal transducer which can detect pressure so small that it registers the air pressure from the flutter of tiny wings. Beast in the picture is a housefly, whose wings are kicking up a measurable air pressure. The "Variducer" has a variability feature which permits prestressing of the crystal to any desired level within its compressive strength. Features: High accuracy, low noise.



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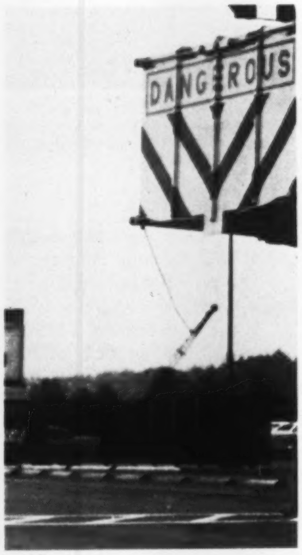
2 **MISSILE ON TIRES.** B. F. Goodrich tires carry this Minuteman Transporter-Erector, believed to be the largest unit ever designed for regular highway transport. The vehicle weighs 108,000 lb loaded, is 64 ft long, 10 ft wide. The trailer unit has two telescoping hydraulic actuators, one on each side, which enables it to stand 90 deg on end to lower the missile into its launching silo, or to lift it out for replacement. During this operation, the trailer tires carry the entire weight.



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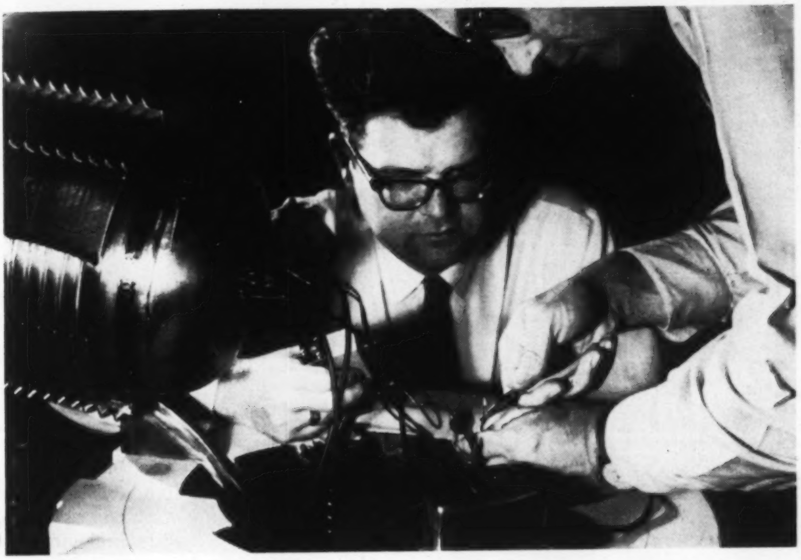
3 **PRESSURE CHAMBER.** A World War II howitzer has become a pressure chamber in the Palo Alto research laboratories of the Lockheed Missiles and Space Company. With the barrel amputated—and the open end sealed with a steel plug—the remaining 5-ft breech and firing chamber comprise a chamber in which pressures up to 12 tons per sq in. can be generated The sawed-off cannon is used to test instruments designed for use at great depths by submarines or "bathyscaphs."

4 **ULTRASONIC SPLICE.** International Ultrasonics, Inc., of Cranford, N. J., produces endless polyester belts with strong, flat, flexible, smooth-running splices made without heat or adhesives. The overlapping ends are traversed by an ultrasonic vibrating horn which transmits energy through the polyester, bringing the surfaces within atomic distance of each other—they adhere positively, with only mild clamping pressure. Joints are as strong and flexible as the basic material.

5 **ALUMINUM CON RODS.** Forged by Kaiser Aluminum and Chemical Corporation, Oakland, Calif., these connecting rods are marketed by Iskenderian Racing Cams of Inglewood, Calif. They are shown here as they look in a fuel-injection Chevrolet V-8. The new rod is said to dissipate heat better than a stock rod, and, as a result, provides longer life for bearings. Although lighter than the factory rod, the aluminum product is more than four times stronger. Iskenderian may soon be offering them for Chrysler, Oldsmobile, and Pontiac engines.

INFRARED BINOCULAR. The soldier at the wheel can see in the dark, using binoculars under development by the U. S. Army Engineers Research and Development Laboratories. Basis: An infrared converter tube, with optics. The glass element, by American Optical Company, Buffalo, N. Y., is sealed to the housing with an adhesive made by Armstrong Cork Company, Lancaster, Pa.



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DANGEROUS
U.S. AIR FORCE

4

5

Engineering
Progress in the
British Isles and
Western Europe

EUROPEAN SURVEY

J. FOSTER PETREE
European
Correspondent

Bypass Jet Engine

The Aero Engine Division of Rolls-Royce Ltd., Derby, England, are now testing a new bypass jet engine, the Spey, which is to be used to power the British Aircraft Corporation's "One-Eleven" short-haul transport aircraft and the de Havilland Trident medium-range aircraft. British European Airways have 24 Tridents on order, the first of which came off the production line in August. Five development Spey engines are now running.

The Spey will have a minimum guaranteed static thrust of 9850 lb at sea level. The fuel consumption at 25,000 ft and Mach 0.78 is expected to be 0.766 lb/hr/lb. The engine has an over-all length of 9 ft 2 in. from intake face to the flange of the exhaust cone, and a diameter of 37 in. Its dry weight is 2200 lb.

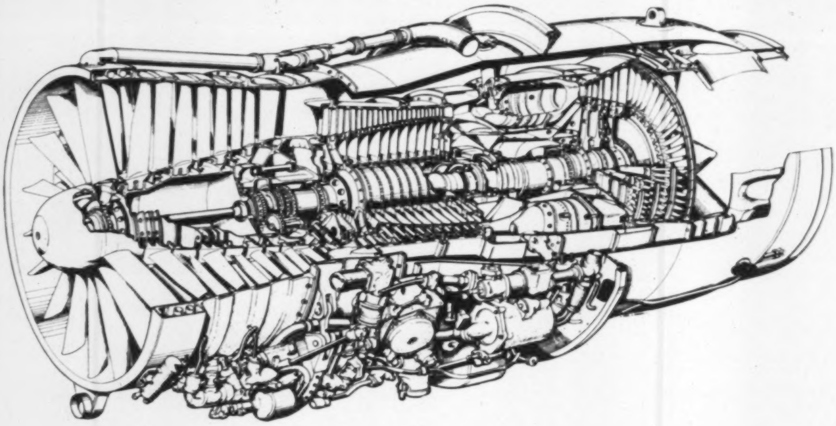
New design features of the Spey (which is a development of the earlier RB.141 engine) include the fuel-control system, the low-pressure compressor, and the mixer, which directs bypass air into the turbine exhaust. The new fuel control is of the speed-selection type and, as estimated by Rolls-Royce, should be "less dirt-conscious and less leak-prone" than earlier systems. The compressor is a simple drum carrying four stages of rotor blading—a construction which is not entirely novel, as it has been tried out on some of the later Conway engines. The mixer has individual chutes to lead the bypass air into the engine exhaust. This insures thorough mixing to give lower exhaust velocity and benefit fuel consumption.

Fueling Reactors on Load

The United Kingdom Atomic Energy Authority have been experimenting with the Calder Hall reactors to see what happens when fuel elements are loaded into a reactor while it is running at full power, and also what effects frequent variations in temperature (thermal cycling) have on fuel elements. These reactors, first put on load five years ago, were designed to be refueled when shut down and depressurized, but the new stations now nearing completion will be refueled while running and it was desired to know if the elements could withstand the temperature changes involved.

The element to be tested was suspended from a control-rod mechanism that was modified to give the required speed of insertion and to hold the element at the desired depth. The requisite changes of temperature were obtained by varying the flow of CO_2 through the channel, taking account also of the heat of the test element and of others near to it. The irradiated elements, when examined in the metallurgical and radiographic laboratories, were found to have suffered no significant effect by on-load charging.

To discover the effect of thermal cycling, two control rods were oscillated up and down in the reactor core to produce temperature changes in adjacent channels. After the rods had been lowered and raised about 13,000 times, the neighboring fuel elements were removed and examined. In this case also, there were no measurable ill effects.



Cut-away drawing reveals internal design details of Rolls-Royce RB. 163 Spey bypass jet engine. The Spey is of twin-spool design, the four-stage low-pressure compressor followed by a 12-stage high-pressure compressor. Engine has minimum guaranteed take-off thrust of 9850 lb.

Test core of graphite taken from reactor is extracted from cutter head of coring machine. Cutting tool hangs at end of 50-ft hose carrying circuits by which tool is operated.

Welding tantalum in an atmosphere of the inert gas, argon, at the Royal Dutch/Shell Amsterdam laboratory. Essentially the same technique is used to line a steel vessel.

Sampling Irradiated Graphite

The Calder Hall nuclear power station, in the county of Cumberland, England, has been working for five years. The first atomic power station to provide a regular public supply of electricity, it was officially connected to the national grid system by Queen Elizabeth II on October 17, 1956. The reactors are of the gas-cooled, graphite-moderated type.

Graphite grows slightly in size when subjected to radiation, and this effect (Wigner growth) had been allowed for in stacking the blocks by leaving small gaps between them. The stacking was so arranged that most of the growth would take place horizontally. The United Kingdom Atomic Energy Authority wished to know how the graphite had been affected by prolonged irradiation, and also whether the actual Wigner growth corresponded with the calculated amounts. To measure the gaps they used a specially constructed television camera, only 3 in. diam, which was lowered into the cores when the reactor was shut down. By this means the gaps were measured with an accuracy of plus or minus 0.01 in. and the changes were found to agree with the predictions.

To sample the graphite a special cutting tool was used, 3 in. diam and 30 in. long, attached to the end of 50 ft of hose containing the electric, pneumatic, and hydraulic circuits by which it was remotely operated. This was lowered down a control-rod hole to the point where the sample was to be taken and was held there by jacks, extended hydraulically. On the side opposite to the jacks an electrically driven rotary cutter, carried in a diametral hole in the body of the tool, was set in motion and fed forward into the graphite, trepanning out a cylindrical core. The cutter was then retracted, taking the core with it, while cool carbon dioxide was blown down onto the tool to clear it of graphite dust, which was sucked out through a duct in the hose. The different stages in the operation were automatically reported back to the control position by an electrical signaling system. A separate hydraulic circuit enables the cutter to be retracted independently of the normal drive in emergency.

Tantalum in Chemical Plants

The metallurgical laboratory of the Royal Dutch/Shell oil companies at Amsterdam, Holland, has been investigating ways of using a thin coating of tantalum as lining for pressure vessels. Tantalum has a very high corrosion resistance—comparable with that of glass—but it is a rare metal and very expensive. Also, it is exceptionally difficult to weld, either to itself or to other materials. It cannot be welded in air because it then becomes brittle, and it does not make a satisfactory bond with steel.

It can be welded in an inert atmosphere of argon, as is done with titanium, but control must be more accurate than with titanium because tantalum has a melting point of about 5425 F and warps badly. Warping is prevented by holding the metal in fixtures that allow the back of the weld to be protected by argon. Small components, or parts of intricate shape, are welded in an argon-filled box.

The same technique of argon protection is used in attaching a tantalum lining to a steel vessel. Strips of the metal are riveted to the inside of the vessel in pairs, edge to edge so that they can be joined by welding; these are backing strips, to which thin sheets of tantalum lining will be secured by spot welding. Between each pair of parallel backing strips a groove is left, about 9 mm wide, to serve as a channel for the distribution of argon gas to the back of the weld. The argon is fed into the channels through holes drilled in the steel shell of the vessel. The panels of the lining are arranged to overlap slightly and are joined by fusion welds to form a complete internal coating of noncorrodible material.

Correspondence with Mr. Petree should be addressed to 36 Mayfield Road, Sutton, Surrey, England.

Substance in
Brief of Papers
Presented at
ASME Meetings

KAREN SODERQUIST
Editorial Asst.

ASME TECHNICAL DIGEST

Metals

An Analysis of the Time and Temperature Dependence of the Upper Yield Point in Iron..61—Met-1...By P. E. Bennett and G. M. Sinclair, Mem. ASME, University of Illinois, Urbana, Ill. 1961 ASME Metals Engineering Conference paper (in type; to be published in **Trans. ASME—J. Basic Engng.**; available to Feb. 1, 1962).

This investigation was conducted to extend previously developed concepts of the time and temperature dependence of the upper yield point of metals having the body centered cubic lattice structure. Ingot iron was tested in torsion over a range of strain rates from 10^{-4}/sec to 10/sec and over a temperature range from that of liquid nitrogen to a temperature sufficient to cause a disappearance of the upper yield point effect.

Of major interest was the exploration of a relationship between yield stress, strain rate, and temperature. It was also desired to determine if an activation energy could be associated with the time and temperature dependence of the yield point in iron.

The results of the investigation compared with tensile test data from other investigators confirm that state of stress is an important factor in determining whether a material will behave in a ductile or brittle fashion.

Theoretical and Experimental Residual Stresses in Quenched Steel Cylinders..61—Met-6...By H. G. Landau, Columbia University, New York, N. Y.; E. H. Hess, U. S. Army Ordnance Department, Philadelphia, Pa.; and E. E. Zwicky, Jr., Mem. ASME, General Electric Company, Schenectady, N. Y. 1961 ASME Metals Engineering Conference (multilithographed; available to Feb. 1, 1962).

In the heat-treatment of metals the transient temperature distribution can frequently develop stresses large enough to cause plastic yielding, and there will then be residual stresses remaining in the body after completion of the treatment. These stresses may be beneficial or harmful, depending on the use to which the treated object is put, and it is therefore desirable to be able to predict them. However, any analytical prediction of residual stresses necessarily includes some idealization about the behavior of the material and must therefore be checked against actual measurements.

Residual stresses in a quenched cylinder are determined on the basis of previously developed equations assuming an elastic, perfectly plastic material with temperature-dependent yield stress. These are compared with measured stresses in tests on subcritically quenched cylinders, using the boring out technique, and satisfactory agreement is obtained. It is concluded that inclusion of strain-hardening in the theoretical equations might give even better agreement.

Elastic and Creep Characteristics of a Class of Shell Closures With Constant Stress Ratio..61—Met-3...By A. E. Gemma, G. H. Rowe, and R. J. Spahl, Pratt and Whitney Aircraft Division, United Aircraft Corporation, Middletown, Conn. 1961 ASME Metals Engineering Conference paper (in type; to be published in **Trans. ASME—J. Basic Engng.**; available to Feb. 1, 1962).

Within the membrane theory of shells, a method is developed for analyzing elastic and creep behavior of a class of pressure vessel closures with constant stress ratios, $\sigma\theta/\sigma\phi = K\ (1 < K < 2)$. A closure designed with $K = 4/3$ was tested at room temperature and showed good agreement with theory. Equations for the creep deformations were developed using the Soderberg relationships together with a power law for steady creep. The same closure was tested in creep at 1500 F for 1000 hours with an internal pressure of 147 psi.

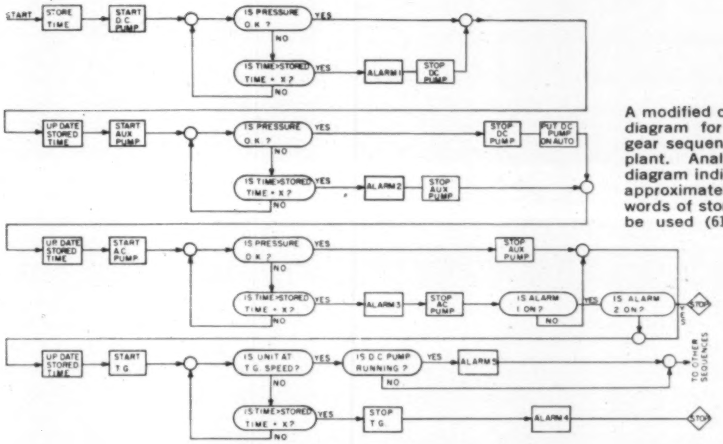
The measured deformations were of the same order of magnitude of predicted growth, but both were small enough to be within the tolerances of the closure vessel dimensions and, therefore, correlation of experimental and theoretical creep growth was obscured. The vessel was retested with an increased internal pressure of 216 psi and it developed a leak after 594 hours. The internal pressure was maintained for an additional 238 hours before the test was stopped. The measured deformations were approximately twice those predicted by theory. A second vessel, identical to the first closure, was tested at 1500 F for 498 hours. These results correlated with theory. A possible explanation for the disagreement in the second creep test is that the vessel was in third stage creep after the leak developed.

An Energy Criterion for Low-Cycle Fatigue..61—Met-4...By D. E. Martin, General Motors Research Laboratories, Warren Mich. 1961 ASME Metals Engineering Conference paper (in type; to be published in **Trans. ASME—J. Basic Engng.**; available to Feb. 1, 1962).

A criterion for low-cycle fatigue is developed that supposes the segment of strain hysteresis associated with work-hardening is a measure of damage. On the basis of this "damage" work criterion and assuming a linear work-hardening law, the well-known plastic strain-cyclic life equation, $N^{1/2}\Delta\epsilon_p = C$ is derived. The constant C in this equation is evaluated by setting the total damage energy absorbed in N cycles equal to the damage work of a static tensile test. This method of predicting the constant C is in much better agreement with room-temperature strain-cycling data than the previously suggested method of plotting the fracture ductility at $1/4$ cycle.

Effects of Interrupted Quenching Procedures on Properties of Type 410 Stainless Steel..61—Met-5...By J. Bressanelli, Crucible Steel Company of America, Pittsburgh, Pa., and J. Hoke, Penn State University, University Park, Pa. 1961 ASME Metals Engineering Conference paper (in type; to be published in **Trans. ASME—J. Basic Engng.**; available to Feb. 1, 1962).

The impact strength of hardened Type 410 stainless steel is known to be adversely affected when the steel is tem-



A modified computer flow diagram for turning-gear sequences in a power plant. Analysis of diagram indicates that approximately 110 words of storage must be used (61—SA-65).

pered between 750 and 1050 F. However, a desirable combination of other properties may be obtained by tempering within this range.

An investigation was performed to determine the extent of improvement in impact strength that may result from certain variations in heat-treating procedures. The hardening operation was studied thoroughly, and a large number of commercial heats was included to establish the consistency of results.

It was found that the cooling rate through the martensite transformation range has a significant effect upon the impact properties after subsequent tempering. Rapid cooling such as that which occurs during oil quenching is detrimental, but air cooling of 0.4-in-diameter bar samples was sufficiently slow to bring about a marked improvement.

Effects of Specimen Size and Notch Acuity on the Brittle Fracture Strength of a Heat-Treated Steel..61—Met-2... By S. Yukawa and J. G. McMullin, General Electric Company, Schenectady, N. Y. 1961 ASME Metals Engineering Conference paper (in type; to be published in **Trans. ASME—J. Basic Engng.;** available to Feb. 1, 1962).

Results of fracture tests on notched specimens of a heat-treated alloy steel indicate that an arrested cleavage or fatigue cracks lowers the brittle fracture strength by about 35 per cent compared to a machined notch with approximately 0.005 in. radius. This difference is observed if the specimen size is sufficiently large; with decreasing size, the difference becomes less and may disappear altogether if relatively small specimens are tested. By nitriding the notch, it appears possible to obtain effects with machined radius notches equivalent to cracks. The concepts of the modified Griffith theory of fracture and of limiting notched strength are utilized to indicate the conditions under which notch acuity effects may be observed.

Automatic Controls

Dynamic Representation of a Large Boiler-Turbine Unit..61—SA-69... By J. H. Daniels, Philadelphia Electric Company, Philadelphia, Pa.; Mark Enns, Westinghouse Electric Corporation, East Pittsburgh, Pa.; and R. D. Hottenstine, Mem. ASME, Combustion Engineering Company, Windsor, Conn. 1961 ASME Summer Annual Meeting paper (multilithographed; available to April 1, 1962).

A mathematical representation is developed for the boiler, turbine, and auxiliaries of a large central-station unit. A set of nonlinear, ordinary (lumped-parameter) differential equations is written for each section and linearized so that operation around a given load point can be analyzed in detail. Results of the digital-computer solutions for a number of important plant variables are given as functions of time in response to plant actuators. Limitations in the model developed and phenomena for which an adequate theoretical basis does not exist are discussed.

Operations Research Study of Steam Power Plant Automation..61—SA-66... By J. K. Dillard, Westinghouse Electric Corporation, East Pittsburgh, Pa.; and J. L. Everett, Philadelphia Electric Company, Philadelphia, Pa. 1961 ASME Summer Annual Meeting paper (multilithographed; available to April 1, 1962).

The increasing complexity of modern power plants provides adequate justification for placing them under automatic control. The use of the digital control computer to achieve this automatic control introduces the concept that an over-all systems approach should be taken.

To establish a systems approach, an operations research study of steam-plant operation was undertaken. Described are the specific objectives of the study, organization of the study team, major accomplishments, and the future plans. It is concluded that:

1 A systems-engineering approach to the entire power plant is necessary to maximize benefits from the new solid-state computing devices. Future systems will not be optimum unless plant apparatus and control are designed together. An optimum plant will not result from an optimized control computer applied to optimized plant apparatus. Each will have to be accommodated to the other. This is the systems-engineering approach.

2 While heat rate and reliability improvement are certainly factors in justifying automation, the real economic justification lies in two places: One is in the elimination of manual control apparatus. The other is in the reduction of the cost of generation apparatus when it is designed for strictly automatic operation. This implies that the power plant of the future will have provision for automatic control and rely on it completely. The resulting savings should be significant.

Aspects of Power Plant Automation..61—SA-65... By M. Birnbaum, Westinghouse Electric Corporation, Lester, Pa.; G. Kotnick, Assoc. Mem. ASME, Philadelphia Electric Company, Philadelphia, Pa.; and D. M. Sauter, Assoc. Mem. ASME, Westinghouse Electric Corporation, East Pittsburgh, Pa. 1961 ASME Summer Annual Meeting paper (multilithographed; available to April 1, 1962).

The automation and control of power plants have recently received impetus by the advent of reliable digital computers. Rather than give the details of the computer sequences and equipment involved to automatically start up, operate, and shut down a power plant, this paper presents the philosophy that the authors evolved during their study of the automation of a power plant. In addition, costs are established for applying this phase of automation. The breakdown of costs reveals areas where cost reduction efforts for future plants can best be applied.

Field Testing for Verification of a Dynamic Model..61—SA-68...By H. G. Dallas, Philadelphia Electric Company, Philadelphia, Pa.; and D. M. Sauter, Assoc. Mem. ASME, Westinghouse Electric Corporation, East Pittsburgh, Pa. 1961 ASME Summer Annual Meeting paper (multilithographed; available to April 1, 1962).

The dynamic field testing of a large boiler-turbine-generator unit to verify a theoretical mathematical model of the unit is discussed. The plant variables recorded and the tests executed are described.

Results are presented in the form of time plots, which are compared with the calculated time response of the dynamic model of the plant. In most cases adequate representation was obtained from the model for control system design and evaluation work. Areas of further study to improve the plant model are also indicated.

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Hydraulics

Vibration of Vertical Pumps..61—Hyd-10...By A. Kovats, Mem. ASME, Foster-Wheeler Corporation, New York, N. Y. 1961 ASME-EIC Hydraulic Conference paper (in type; to be published in **Trans. ASME—J. Engng. for Power;** available to March 1, 1962).

Vibration of vertical pumps occurs often, in spite of the fact that calculations of critical frequencies have been made for design purposes. The most frequent sources of disturbing forces that cause vibrations of pumps are:

1 The unbalance of the rotating parts.

2 External vibrations transmitted by the foundation or by the pipeline.

3 Bearing vibrations.

4 Pressure pulsations.

It is shown in this paper that the use of only basic formulas of mechanics is an oversimplification of the problem and that only by taking into account all of the special modifying factors of the pump-driver system can sufficient accuracy be expected.

It is concluded that the safest way to avoid vibration in vertical pumps is to design all parts of the pump for a natural frequency sufficiently above the frequency of the operating speed and to balance the rotating part so that the eccentricity of the center of gravity is smaller than the bearing clearance.

Experimental Investigation of Subsonic Turbulent Flow Over Single and Double Backward Facing Steps..61—Hyd-15... By D. E. Abbott, Vidya Inc., Palo Alto, Calif.; and S. J. Kline, Mem. ASME, Stanford University, Stanford, Calif. 1961 ASME-EIC Hydraulic Conference paper (in type; to be published in **Trans. ASME—J. Basic Engng.;** available to March 1, 1962).

There are many two-dimensional configurations of importance that contain regions of stall; examples are sudden increases in area in a channel, airfoils at large angles of attack, wide-angle diffusers, and so forth. In the present investigation of separated regions, the geometry chosen to produce a stall is the backward facing two-dimensional step, that is, a sudden expansion in the flow direction.

Results are presented for flow patterns over backward facing steps covering a wide range of geometric variables. Velocity profile measurements are given for both single and double steps. The stall region is shown to consist of a complex pattern involving three distinct regions. The double step contains an assymmetry for large expansions, but approaches the single-step configuration with symmetric stall regions for small values of area ratio. No effect on flow pattern or reattachment length is found for a wide range of Reynolds numbers and turbulence intensities, provided the flow is fully turbulent before the step.

Adiabatic Flow of Flashing Liquids in Pipes..61—Hyd-7...By M. Sajben, Assoc. Mem. ASME, Westinghouse Electric Corporation, Lester, Pa. 1961 ASME-EIC Hydraulic Conference paper (in type; to be published in **Trans. ASME—J. Basic Engng.;** available to March 1, 1962).

The assumption of a homogeneous fluid in thermodynamic equilibrium has frequently been made in describing the behavior of a vapor-liquid mixture flowing in constant area pipes. Although this flow model is acceptable for a range of conditions, its extensive use has been prohibited by the large amount of computational labor involved. The equations of this flow model are reviewed, several conventional but unnecessary restrictions are removed, and computed results are presented on working charts suitable for practical purposes. Critical

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Solar Energy

New Applications of Thermodynamic Principles to Solar Distillation..61—SA-45...By Werner N. Grune, T. Lewis Thompson, and Richard A. Collins, Georgia Institute of Technology, Atlanta, Ga. 1961 ASME Summer Annual Meeting paper (multilithographed; available to April 1, 1962).

The development of methods for predicting the rate of production from natural and forced-convection solar stills is presented. The analysis is based on "internal" heat and mass-transfer conditions. A humidity function is developed for forced-convection stills relating production rate to the humidities at the water basin and cover by application of a mass balance about the air space.

The rate of production in natural-convection stills is apparently controlled by the rate of diffusion of water vapor from the brine surface through stagnant-air films.

The thickness of the films are determined by temperature and density gradients existing within the still. Using the methods presented, future designs may be more realistically evaluated.

Performance of a Solar Still..61—SA-38...By Carlos R. Garrett, Assoc. Mem. ASME, University of Puerto Rico, Mayaguez, Puerto Rico; and Erich A. Farber, Mem. ASME, University of Florida, Gainesville, Fla. 1961 ASME Summer Annual Meeting paper (multilithographed; available to April 1, 1962).

The performance of a roof-type solar distiller is analyzed with respect to variations in distilland layer thickness and season of the year. Thermal losses are determined for different times of the day. Efficiencies are calculated. Batch-type process was utilized, varying the total amount of distilland in the evaporator from day to day. An analysis of the losses showed the one by radiation to be the greater, and the one by conduction to be the lesser. The output varied with the time of the year, but the efficiency based on the daily output remained essentially constant. Small batches were conducive to higher efficiencies.

Solar Distillation Research at the University of California..61—SA-37...By Everett D. Howe, Mem. ASME, and Lester H. MacLeod, Sea Water Conversion Laboratory, University of California, Berkeley, Calif. 1961 ASME Summer Annual Meeting paper (multilithographed; available to April 1, 1962).

Performance data and heat balance information are presented for a greenhouse-type solar still 8 ft × 50 ft in size. Maximum efficiencies of 30 to 40 per cent are reported for clear days, the efficiency increasing with solar intensity. From this information and tests of other types of solar stills, it is concluded that high efficiencies of operation require high temperatures within the still structure. It is suggested that conditions favorable to high efficiencies include low ratios of glass condensing surface to water evaporating surface, good insulation, and short distances between water and glass surfaces.

flow rates and the amount of subcooling necessary to avoid flashing in the pipe were given special attention.

Nonsteady Supercritical Discharge Through an Orifice..61—Hyd-17... By George Rudinger, Cornell Aeronautical Laboratory, Inc., Buffalo, N. Y. 1961 ASME-EIC Hydraulic Conference paper (in type; to be published in **Trans. ASME—J. Basic Engng.;** available to March 1, 1962).

Previous studies of shock reflection from open-ended duct configurations indicate that a steady discharge is not instantaneously formed and that the effects of this lag may occasionally be important. A theory is available that satisfactorily describes the lag effects in subcritical flow, but its validity for supercritical flow has not previously been verified. Shock-tube experiments are therefore carried out to study the lag effects in supercritical flow from a sharp-edged orifice. The incident shock wave either modifies an initial supercritical discharge, or establishes such a discharge with the gas initially being at rest. Schlieren photographs show a violent transition of the flow downstream of the orifice that lasts several milliseconds. Pressure records taken inside the duct indicate a small, but distinct, pressure rise that also lasts for several milliseconds following the passage of the reflected shock wave. It is shown that this apparent agreement of the transition time is accidental.

A method is described to evaluate the effect of boundary-layer growth on the pressure behind the reflected shock wave, and the results indicate that the entire observed pressure rise is accounted for by this effect. Consequently, flow adjustment in the orifice may be considered as instantaneous for all practical purposes.

High-Head Francis Turbines for Mammoth Pool..61—Hyd-21... By Luther Brown, Mem. ASME, Allis-Chalmers Manufacturing Company, York, Pa. 1961 ASME-EIC Hydraulic Conference paper (multilithographed; available to March 1, 1962).

The Mammoth Pool Hydroelectric Project is owned and operated by the Southern California Edison Company of Los Angeles, Calif. It is located about 60 miles northeast of the city of Fresno on the Upper San Joaquin River.

The Mammoth Pool turbines, rated at 88,000 hp under 950 ft net head at 360 rpm, are the largest, high-head Francis units in the United States. The maximum net head is 1032 ft. These units were furnished complete with inlet butterfly valves, relief valves, and a tailwater depressing system. The hydraulic and mechanical features of the turbines and auxiliaries are discussed in sufficient detail to serve as a guide for future developments of a similar nature. The results of the field test are given in curve-form showing a peak efficiency of 92.7 per cent at the rated head.

The Phase-Plane Topology of the Simple Surge-Tank Equation..61—Hyd-9... By A. W. Marris, Mem. ASME, University of Texas, Austin, Texas. 1961 ASME-EIC Hydraulic Conference paper (in type; to be published in **Trans. ASME—J. Basic Engng.;** available to March 1, 1962).

An investigation is made of the phase-plane solution curves of the nonlinear differential equation describing the motion of the water level in a simple surge tank operating in conjunction with a turbine governed for constant hydraulic power acceptance.

The phase-plane solution picture is developed by determining the form of the solution of the equation near each of its singularities. The picture enables prediction and interpretation of instability and drainage phenomena. It shows that the Thoma condition must always give instability, and allows an interpretation of the results of Evangelisti and Paynter. Giving a priori insight into the qualitative aspects of the total solution, and showing which terms are influential in which particular regions, the map should facilitate the programming for digital computers.

Local Liquid Distribution and Pressure Drops in Annular Two-Phase Flow..61—Hyd-20... By H. N. McManus, Jr., Assoc. Mem. ASME, Cornell University, Ithaca, N. Y. 1961 ASME-EIC Hydraulic Conference paper (multilithographed; available to March 1, 1962).

Empirical correlations are presented for local liquid-film thickness in horizontal annular flow for a wide range of flow conditions. Comparisons of measured liquid-area fraction are made with those predicted by the Martinelli correlation. Measured pressure drops are compared with those predicted by the Martinelli and Chenowith-Martin correlations. Separation of pressure drops into component parts was accomplished. Momentum pressure drops were found to depend on gas Reynolds number.

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Machine Design

On the Variety of Motions Generated by Mechanisms..61—SA-3... By Ferdinand Freudenstein, Assoc. Mem. ASME, Columbia University, New York, N. Y. 1961 ASME Summer Annual Meeting paper (in type; to be published in **Trans. ASME—J. Engng. for Indus.;** available to April 1, 1962).

In many branches of science there are laws comprising assertions concerning the possibility or impossibility of achieving certain results. In applied kinematics, also, it is natural to inquire about the limitations of the motions achievable by means of mechanisms.

The analysis of the nature of curves that can be generated by points on mechanisms is described in two theorems; the first concerning plane mechanisms with turning pairs, and the second concerning mechanisms in general.

It is concluded that the cyclical repetition of curve generation, or the law of the average gear ratio, is an invariant of a particular mechanism, generally independent of the proportions, just as are the degrees of freedom. It is, therefore, a topological property.

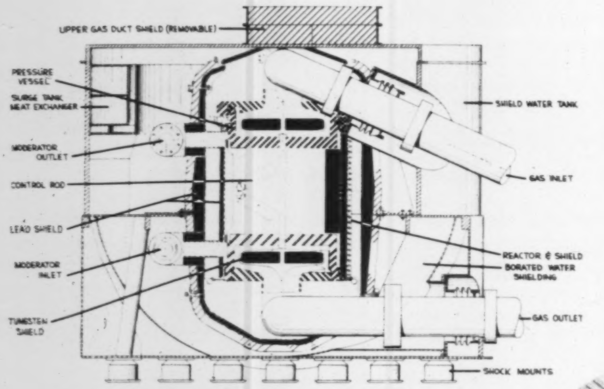
Synthesis of Rectilinear Motion by Mechanical Harmonic Function Generators..61—SA-4... By Bernard W. Shaffer, Mem. ASME, New York University, New York, N. Y.; and Irvin Krause, American Standard, Union, N. J. 1961 ASME Summer Annual Meeting paper (in type; to be published in **Trans. ASME—J. Engng. for Indus.;** available to April 1, 1962).

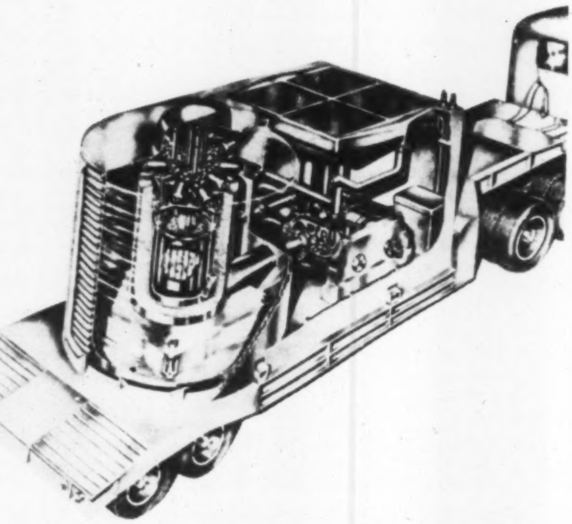
A general method is presented for generating controlled rectilinear motion to any desired accuracy. The required motion is expressed in terms of a Fourier series whose coefficients are shown to be related to the governing dimensions of a plane mechanism. The mechanism may be designed to generate enough terms of the Fourier series to satisfy any desired accuracy. The technique is then used for a particular problem to illustrate its application and the method by which the error of approximation may be evaluated.

The Superposition of Stress Concentration Factors..61—SA-5... By Frank W. Paul, Jr., Mixing Equipment Company, Inc., Rochester, N. Y.; and Thomas R. Faucett, Mem. ASME, University of Missouri, School of Mines and Metallurgy, Rolla, Mo. 1961 ASME Summer Annual Meeting paper (in type; to be published in **Trans. ASME—J. Engng. for Indus.;** available to April 1, 1962).

A photoelastic study was made of the superposition of stress raising notches. Recent investigations have indicated that where one stress raising notch is placed in the region of maximum influence of a second notch the resulting stress concentration factor may be determined by taking the product of the concentration factors for the individual notches. Test results presented gave general although not precise agreement with this method of combination.

The tests of the authors' first reference (A. Q. Mowbray, Jr., "The Effect of Superposition of Stress Raisers on Members Subjected to Static or Repeated Loads," *Proceedings, SESA*, vol. X, 1953,





The ML-1 reactor package, **above,** is the mobile, low-power prototype for the U. S. Army's mobile reactor program. The package is mounted on an elastomer-base, shock-mount pad system (61—SA-43). The basic plant, being towed, **right,** consists of a 15-ton reactor package, a 15-ton power-conversion package, and a 2½-ton control package. Plant may be operated from semi-trailer. Standard 45-kw diesel-electric set provides start-up and shutdown power (61—SA-42).

p. 153), were performed on specific materials for static and repeated loads and hence combine the effects of stress concentration with the sensitivity of the particular material. The tests of the second reference (T. C. James, "Determination of Stress Concentration Factors by the Brittle Materials Method Using Kriston," MS thesis, Department of Theoretical and Applied Mechanics, University of Illinois, June, 1950), run on a brittle material indicate the same general agreement.

Normal practice for applying stress-concentration factors separates the two effects, that is the actual concentration of stress and the sensitivity of the material to such concentration. It was believed that photoelasticity might yield a better verification of the method for combining superposed stresses as photoelastic methods have shown close agreement with theoretical factors of stress concentration. Results of the present investigation indicate that the product gives the combined concentration factor with the same degree of accuracy to which the individual factors are known.

A mathematical analysis was made to determine the stresses across the section.

On the Kinematics of Rubber-Covered Cylinders Rolling on a Hard Surface..61—SA-67...By George N. Sandor, Mem. ASME, Time Inc., Springdale Laboratories Division, Springdale, Conn. 1961 ASME Summer Annual Meeting paper (multilithographed; available to April 1, 1962).

A practical method is presented for calculating the percentage of surface-speed difference from the dimensions of the hard and rubber-covered rollers and the deformation of the rubber. The derivations are based on a mass-flow analogy, in which the movement of the rubber covering is studied as it "flows" across the nip.

The resulting method of calculation is arranged in an easy-to-use computation form, suitable for solution by means of a desk calculator or by means of programming an automatic digital computer.

Results computed with the use of this form are in general agreement with experimental findings. The cases of rolling a resilient roller on a hard plane surface and a hard roller on a rubber-covered plane surface are also treated.

Thermal Stresses in Spherical Case-Bonded Propellant Grains..61—SA-15... By Irvin Krause, American Standard, Union, N. J.; and Bernard W. Shaffer, New York University, New York, N. Y. 1961 ASME Summer Annual Meeting paper (in type; to be published in **Trans. ASME—J. Engng. for Indus.;** available to April 1, 1962).

Expressions are derived for the bond stresses induced by a radially symmetric temperature distribution in spherical propellant grains bonded to spherical casings. Equations for the evaluation of radial and tangential stresses in the propellant and its casing have also been derived. Both solid and hollow propellant grains have been investigated. Design considerations have been developed to enable the designer to minimize the bond stress. A comparison between the hollow and solid spherical propellant assembly shows that the hollow sphere has a lower bond stress than the solid sphere, assuming all other factors are the same.

Nuclear Engineering

Compact Reactor Development for Ground Nuclear Power Applications.. 61—SA-42...By Melvin A. Rosen, Theodore W. McIntosh, and Richard A. Du Val, Atomic Energy Commission, Washington, D. C. 1961 ASME Summer Annual Meeting paper (multilithographed; available to April 1, 1962).

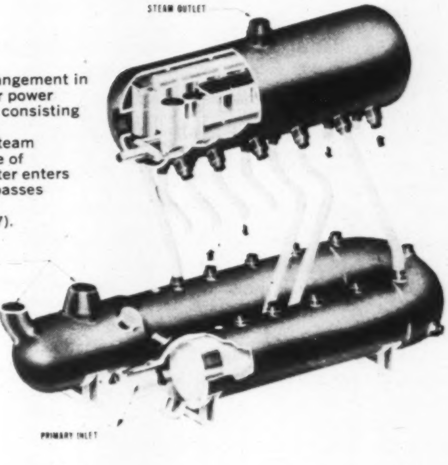
The Army Nuclear Power Program (ANPP) is a joint program of the Atomic Energy Commission and the Department of Defense with the objective of developing a variety of nuclear plants to meet military requirements for ground nuclear power at remote installations and with mobile military units. In meeting this objective, the Army Program has applied nuclear-reactor technology to unique and previously unexplored ranges of power and transportability characteristics and has stimulated significant effort by the nuclear industry to fill this technological need.

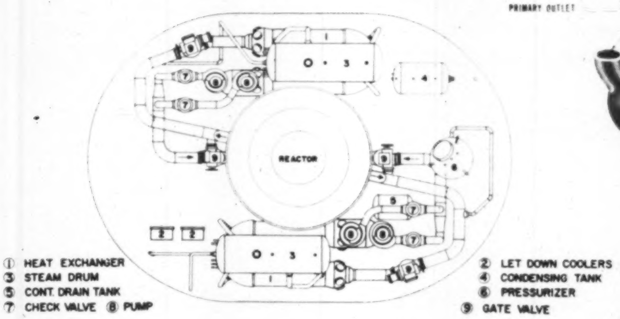
The plants under development in the Army program cover the technologies of pressurized-water, boiling-water, gas-cooled, and liquid-metal-cooled reactors. Discussed are typical stationary plants, portable plants, and mobile reactors, including the Military Compact Reactor (MCR) Program. The size, transportability, and lifetime development objectives of the Army Nuclear Power Program are described.

The ML-1 Mobile Nuclear Power Plant.. 61—SA-43...By S. A. Varga, R. K. Swain, and J. C. Whipple, Aerojet-General Nucleonics, San Ramon, Calif. 1961 ASME Summer Annual Meeting paper (multilithographed; available to April 1, 1962).

A design description of the ML-1 mobile nuclear power plant is presented.

Drawing, **below,** shows equipment arrangement in containment vessel of NS Savannah nuclear power plant. It is of pressurized-water type, consisting of a single reactor with two main coolant loops and two steam generators. Steam generator for system is U-shaped bundle of tubes encased in shell, **right.** Primary water enters through one end of the U-shell, passes through the tubes, and discharges from the other end (61—SA-57).





The ML-1 plant will serve as an operating prototype for future remote power generating stations. It is to be transportable by several types of aircraft, ship or barge, railroad flatcar, and on standard Army trailers.

The ML-1 plant consists of a high-temperature, gas-cooled, water-moderated reactor coupled to compact power-conversion equipment. This closed-cycle, gas-turbine power plant will have an electrical generating capacity of 300 to 500 kw. The ML-1 reactor was installed at the National Reactor Testing Station early in 1961. Reactor criticality was scheduled for April, 1961, and full-plant operation for winter, 1961.

Design and Testing of Sodium Pumps for the Hallam Nuclear Power Facility.. 61—SA-39... By R. E. Ball and D. E. Cullman, Borg-Warner Corporation, Los Angeles, Calif.; and R. W. Atz, Atomics International, Canoga Park, Calif. 1961 ASME Summer Annual Meeting paper (multilithographed; available to April 1, 1962).

The three primary and three secondary sodium circulating pumps for the Hallam Nuclear Power Facility were built for Atomics International, a division of North American Aviation, Inc., by Byron Jackson Division, Borg-Warner Corporation. The primary pumps operate at a flow of 7200 gpm against a head of 160 ft at a speed of 835 rpm, circulating 1000 F sodium from the reactor through the intermediate heat exchanger where heat is transferred to the secondary sodium. The secondary pumps have the same operating conditions as the primary pumps. They circulate 900 F sodium through the intermediate heat exchanger and the steam generator where steam is produced at 850 psi and 833 F. All pumps are of the centrifugal type, vertically mounted, the primary pumps being longer because of the radiation shield plug built into the pumps.

The design features of these sodium-circulating pumps are described in detail. Relative costs of various variable-speed drives and gas-sealing devices are discussed. The performance of one pump tested with sodium is presented.

Erection and Precritical Testing of the NS Savannah Power Plant..61—SA-57... By C. W. Hasek, Jr., The Babcock & Wilcox Company, Lynchburg, Va. 1961 ASME Summer Annual Meeting paper (multilithographed; available to April 1, 1962).

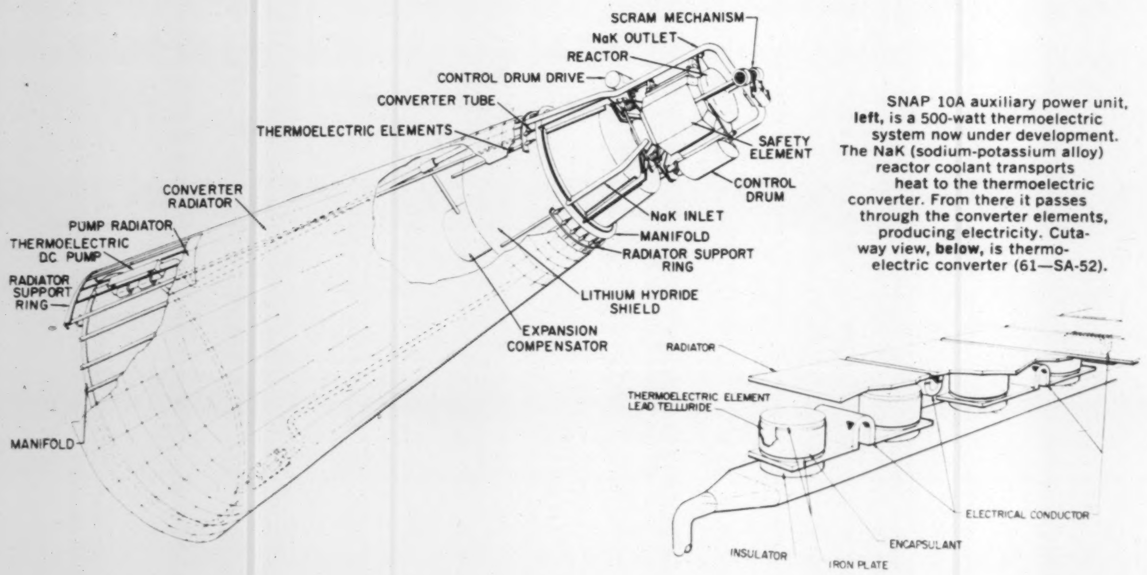
The reactor system of the NS *Savannah*, the first nuclear merchant ship, is the pressurized-water type consisting of a single reactor with two main coolant loops and two steam generators. Primary water at a pressure of 1750 psia generates saturated steam at 470 psia at full power. This steam expands through high and low-pressure turbines and discharges to the main condenser at 28.5 in. Hg vacuum. Condensate pumps pump the water from the condenser through the main air ejectors and first-stage heater to the deaerating feedwater heater. The main feed pumps send the feedwater through a high-pressure heater and back to the boilers in the reactor system. Two 1500-kw turbine generators provide power for all propulsive and ship service auxiliaries. A low-pressure heat exchanger provides a maximum of 7500 lb of steam per hr for hotel services and cargo heating.

The principal features of this power plant are outlined with particular reference to the reactor system. Prototype testing of the principal components of the reactor system are reviewed in detail. Installation of the major components in the containment vessel and testing of the system up to fueling the reactor are described.

Design of Reliable and Economical Heat Exchangers for High Temperature Sodium Service..61—SA-41... By Roy D. Seifert and Laurence E. Phillips, Alco Products, Inc., Schenectady, N. Y. 1961 ASME Summer Annual Meeting paper (multilithographed; available to April 1, 1962).

In conjunction with the development of sodium-cooled reactor systems for producing economic electric power from nuclear energy, a research and development program has been sponsored by the United States Atomic Energy Commission to develop less expensive and more reliable sodium components. As part of the AEC objective, a detailed program was undertaken to design and fabricate a sodium-to-sodium intermediate heat exchanger and a sodium-to-water steam generator.

A report is presented on problems encountered in design optimization of the intermediate heat exchanger and steam generator for service in a nuclear power plant generating 1200 F sodium. Objective of the design was to attain maximum economy and reliability. The approach to the problem, design criteria, materials selection, and research investigation of design factors are discussed. A brief description of key features in the final design of both units is included.



SNAP 10A auxiliary power unit, **left**, is a 500-watt thermoelectric system now under development. The NaK (sodium-potassium alloy) reactor coolant transports heat to the thermoelectric converter. From there it passes through the converter elements, producing electricity. Cutaway view, **below**, is thermoelectric converter (61—SA-52).

Summary of Snap Nuclear Space Power Systems..61—SA-52... By E. B. Baumeister, Atomics International, Canoga Park, Calif. 1961 ASME Summer Annual Meeting paper (multilithographed; available to April 1, 1962).

The ever-increasing payload capabilities of space-vehicle booster systems require lightweight, long-lived, high-power, reliable electrical power-generating systems. The space power requirements vary from several hundred watts of auxiliary power into the megawatt range for large electrical propulsion applications. The nuclear space power plants, because of their low specific weight, become extremely attractive in the range of several hundred watts and appear to be the only feasible system for power levels over about 30 kw.

The paper reviews developments in this area, and discusses the reactor system, power conversion, orbital startup, and safety considerations.

Testing of a 3000-Kw (Th), Liquid-Metal, Model Steam Generator..61—SA-46... By L. J. Webster, D. E. Fletchall, Assoc. Mem. ASME, and D. Logan, Atomics International, Division of North American Aviation, Canoga Park, Calif. 1961 ASME Summer Annual Meeting paper (multilithographed; available to April 1, 1962).

Two configurations of a 3000-kw (th), bayonet-tube model steam generator were tested for 8450 hr in a liquid-metal test loop. The two configurations utilized the same superheater and evaporator tube bundle, but different shell designs and types of evaporator core tubes.

Analysis of the evaporator steady-state heat-transfer data showed that the steam-side boiling film coefficient varied markedly from the sodium inlet end of the heat-transfer tube to the outlet end. This caused a corresponding variation in the over-all heat-transfer coefficient and thus invalidated the log-mean-temperature approach as a method for evaluation of the thermal performance. The evaluation was made instead by accounting for the variable boiling resistance through electronic analog simulation of the evaporator.

This method gave good agreement with the measured data. An electronic analog computer model was also used in evaluating the heat-transfer characteristics of the superheater.

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Management

Creating Creativity in Your Employees..61—SA-61... By Arthur L. Logan, U. S. A. F., California Investigators Inc., Van Nuys, Calif. 1961 ASME Summer Annual Meeting paper (multilithographed; available to April 1, 1962).

The problem of creating creativity in one's employees seems to fall into two categories: (*a*) What can you, as managers, do to train employees to be more creative? (*b*) What can you, as managers, do to train supervisers to encourage and help employees to be more creative? Imagination is the main ingredient in creative thinking and how to use it is the basis of this paper. Creative imagination is the power that enables man to excel all other animals.

Obviously, it is the gift that can be most useful to all of us in solving all kinds of problems whether they be those of industrial management, finance, production, research, engineering, public relations, employee relations, advertising, selling, medicine, law, or teaching.

The Influence of Development Objectives Upon Production Costs..61—SA-64... By D. Kenneth Richardson, Hughes Aircraft Company, Culver City, Calif. 1961 ASME Summer Annual Meeting paper (multilithographed; available to April 1, 1962).

Engineering organizations traditionally consider that the majority of product cost control responsibility lies with the production facility.

It is intuitively obvious, however, that the initial performance objectives established for the product have a very great influence upon the ultimate cost and resulting price. This influence is dominant in companies primarily engaged in low production contracts for military hardware, making the traditional engineering attitude quite unrealistic.

In an attempt to measure the true responsibility for product price changes, an analysis was made of a product that had been designed in four successively improved versions and manufactured over a six-year period.

The causes of cost differences between and within the model series were isolated and responsibility was assigned to the probable source.

The results of the analysis indicate in a quantitative manner that more attention to ultimate product cost must be paid in setting initial design objectives. Efforts to incorporate minor performance improvements may cause extremely large product cost increases.

Applied Mechanics

Uniqueness in the Optimum Design of Structures..61—APM-1... By T. C. Hu and R. T. Shield, Brown University, Providence, R. I. 1961 ASME Applied Mechanics Summer Conference paper (in type; to be published in **Trans. ASME—J. Appl. Mech.;** available to April 1, 1962).

The problem of optimum design is to find a structure that will carry given loads and be optimum for a given criterion. The criterion may be minimum volume or minimum moment of inertia. For homogeneous materials, minimum weight coincides with minimum volume.

The following work is concerned with the uniqueness of the optimum design of a sandwich shell. The sufficient condition of reference states that a design is optimum if it is about to collapse in a special deformation mode. It is shown that if an optimum design satisfying this condition exists, then any other optimum design must also admit the special deformation mode as a collapse mode. This result specifies the position of the stress point on the yield surface at every section of a shell of optimum design.

In particular cases, the equilibrium equations may then be sufficient to insure uniqueness of the optimum design, but no general result has been obtained. However, an examination of the optimum designs obtained in previous work shows that they are unique. That nonunique optimum designs may exist when the yield surface contains a flat is shown by an example.

The Effect of a Longitudinal Gravitational Field on the Supercavitating Flow Over a Wedge..61—APM-2... By A. J. Acosta, Assoc. Mem. ASME, California Institute of Technology, Pasadena, Calif. 1961 ASME Applied Mechanics Summer Conference paper (in type; to be published in **Trans. ASME—J. Appl. Mech.;** available to April 1, 1962).

Fully cavitated flows are known to occur in axial gravitational fields. The cavity associated with vertical water entry or exit is one example. An effect similar to that of axial gravity occurs when fully cavitating flow takes place in a large water tunnel with slightly diverging walls. The longitudinal pressure gradient that results from the variable cross section plays a role much like that of a force field. It appears then, that to have an understanding of free-streamline problems in all cases of possible technical interest, the effect of an axial or longitudinal gravitational field must be examined.

The free-streamline flow past a symmetrical wedge in the presence of a longitudinal gravitational field is determined with a linearized theory. The proportions of the cavity depend upon the cavitation number and Froude number. The drag coefficient is likewise affected by gravity, though to a smaller extent.

On Classical Plate Theory and Wave Propagation..61—APM-3... By M. A. Medick, Avco Corporation, Wilmington, Mass. 1961 ASME Applied Mechanics Summer Conference paper (in type; to be published in **Trans. ASME—J. Appl. Mech.;** available to April 1, 1962).

This investigation assesses the applicability of classical plate theory in describing the response of a flat plate of large radius to a sharp, transient loading applied over a small surface area by evaluating its predictions and comparing them with some preliminary experiments.

According to classical plate theory, a localized transient loading produces an aperiodic, oscillatory transverse displacement at all points of the plate. Experiments indicate that, except for an initial time interval, during which the displacement amplitudes are very small fractions of the maximum response, the quantitative predictions of the classical theory are accurate at points in the plate at least several thicknesses removed from the area of loading. On the basis of both theory and experiment, this critical initial time interval is roughly 2 (r/c), where r is the distance from the center of loading, and c is the characteristic velocity $(E/\rho^{1/2})$.

Except for times comparable to the duration of loading, the plate response is primarily dependent upon the total impulse transmitted to the plate, and is dependent to only a much lesser degree on the details of the load-time history; this appears to be borne out not only by theoretical studies, but also by the successful correlation of analytical results with those obtained from penetration tests on plates.

Stress Distribution on the Boundary of a Circular Hole in a Large Plate During Passage of a Stress Pulse of Long Duration..61—APM-4... By A. J. Durelli, Assoc. Mem. ASME, and W. F. Riley, Illinois Institute of Technology, Chicago, Ill. 1961 ASME Applied Mechanics Summer Conference paper (in type; to be published in **Trans. ASME—J. Appl. Mech.;** available to April 1, 1962).

A partial solution to the problem of the stress distribution on the boundary of a circular hole in a large plate during passage of a stress pulse of relatively long duration is presented. The solution was obtained experimentally by using a low-modulus model material in a combined photoelasticity and grid analysis. The long duration stress pulse was applied by loading a small region on an edge of the plate with a falling weight. The hole was placed at a location in the plate where both dilatational and distortional waves would be felt. It was also located in such a way that a symmetric point was available for making free fields stress determinations.

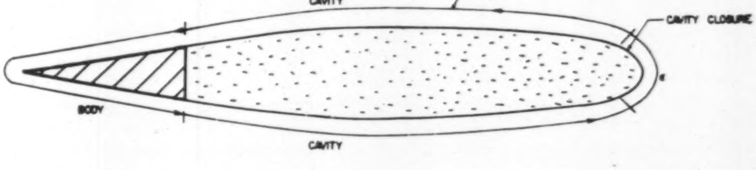
The results of the investigation indicate that a variable biaxial state of stress was produced in the free field. The study also indicates that the maximum compressive stress on the hole boundary can be computed with a fair degree of accuracy by applying the Kirsch solution for a hole in an infinite plate and considering the free-field biaxial stress conditions. The maximum tensile stresses on the hole boundary were always found to be smaller than the values predicted by the Kirsch formula.

An Extension of Duhamel's Analogy to Plasticity..61—APM-9.. By S. A. Murch, Assoc. Mem. ASME, University of California, Berkeley, Calif. 1961 ASME Applied Mechanics Summer Conference paper (in type; to be published in **Trans. ASME—J. Appl. Mech.;** available to April 1, 1962).

When dealing with the deformation of continuous media, it is often possible to find a correspondence between the solutions to boundary-value problems of neighboring disciplines that relates the solution of one problem, through an appropriate transformation, to the solution of the corresponding problem.

It is shown that the Duhamel analogy of classical elasticity theory may be extended without modification to the incremental theory of plasticity, when the loading function is temperature independent. For a class of temperature-dependent loading functions the analogy of the Duhamel type is shown to hold: (*a*) when the temperature field is stationary; (*b*) for problems in which the elastic and plastic components of strain individually satisfy compatibility; or (*c*) when the material is rigid plastic, provided the medium is interpreted as nonhomogeneous. Examples of particu-

Definition sketch of contour used in evaluating drag integral in a supercavitating flow over a wedge with varying longitudinal gravitational field (61—APM-2)



lar correspondences are discussed. It is also noted that for linear viscoelastic materials in which volume changes are purely thermoelastic the transformations in the analogy are identical to those for elasticity.

On the Aeroelastic Instability of Bluff Cylinders..61—APM-8...By G. V. Parkinson, Mem. ASME, and N. P. H. Brooks, University of British Columbia, Vancouver, B. C., Canada. 1961 ASME Applied Mechanics Summer Conference paper (in type; to be published in **Trans. ASME—J. Appl. Mech.;** available to April 1, 1962).

The validity of quasi-steady theory, using experimental aerodynamic coefficients, to explain the observed aeroelastic instability of bluff cylinders in a uniform stream is examined for several cylinder sections. Only plunging oscillation is considered, and the analytical model is an oscillator with nonlinear damping dependent on the aerodynamic coefficients. Static and dynamic wind-tunnel tests were made of cylinder models of square, rectangular, and D-section. The D-section and the short rectangular sections behaved dynamically like the circular cylinder, showing plunge instability only near resonance with the von Karman vortex street. In complete contrast, the square and long rectangular sections showed plunge instability with amplitude increasing with wind speed for all speeds above a critical value. These dynamic results were in good agreement with the theoretical predictions, using the static test data.

Minimum Transfer Time for a Power-Limited Rocket..61—APM-6...By George Leitmann, University of California, Berkeley, Calif. 1961 ASME Applied Mechanics Summer Conference paper (in type; to be published in **Trans. ASME—J. Appl. Mech.;** available to April 1, 1962).

During recent years, many investigations of optimum rocket trajectories have been undertaken. Most of these have dealt with problems of conventional thrust-limited rockets. Within the framework of the general research task, this paper is the first attempt at treating optimization questions involving energy-separate, power-limited rockets.

The problem considered is that of determining the acceleration program leading to minimum transfer time for a power-limited rocket moving between prescribed positions and velocities in a constant gravitational field. It is found that flight must take place at maximum power and that the thrust-acceleration components are linear functions of time. The case of rectilinear transfer between positions of rest is treated in detail, and the results are compared with those previously obtained for a constant-acceleration transfer.

The Effect of a Rigid Elliptic Inclusion on the Bending of a Thick Elastic Plate..61—APM-13...By Fu Chow, Polytechnic Institute of Brooklyn, Brooklyn, N. Y. 1961 ASME Applied Mechanics Summer Conference paper (in type; to be published in **Trans. ASME—J. Appl. Mech.;** available to April 1, 1962).

The effect of a rigid elliptic inclusion on both plain bending and pure twist of a thick elastic plate is investigated on the basis of Reissner's plate theory. Comparison is made for the limiting cases of vanishing focal distance of the elliptic inclusion (a rigid circular inclusion), and vanishing thickness (Poisson-Kirchoff plate theory), with the solutions of C. Pai, R. A. Hirsch, and M. Goland. The stress-concentration factors are lower than those predicted by the classical plate theory.

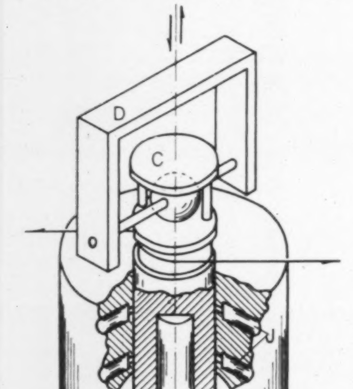


Diagram of test apparatus for studying the bifurcation phenomenon of static friction: A—test block; B—plunger; C—disk for lifting; D—lifting bracket; S—specimens; J—air nozzles (61—APM-7)

It is observed that, at the bond between the rigid inclusion and the plate, the shear-stress resultant in the tangential direction is equal to zero and the ratio between the stress couple in the tangential direction and that in the normal direction is equal to the Poisson ratio. These relations on the basis of Reissner's plate theory may be shown to be in general valid at the clamped boundary of a plate in the absence of lateral loading. The truth of the foregoing moment relation when the classical plate theory is employed has been known.

A Bifurcation Phenomenon of Static Friction..61—APM-7...By F. F. Ling, Mem. ASME, Rensselaer Polytechnic Institute, Troy, N. Y.; and R. S. Weiner, Northwestern University, Evanston, Ill. 1961 ASME Applied Mechanics Summer Conference paper (in type; to be published in **Trans. ASME—J. Appl. Mech.;** available to April 1, 1962).

Measurements are reported of electric contact resistance, actual area of contact, static friction, adhesion, and pure shear for lead on lead. The data exhibit a statistical bifurcation of friction. In other words, below extreme pressures, statistically there are two branches of the coefficient of friction versus normal load relationship. The nature of one of the branches is explicable exclusively in terms of the weld-junction or adhesion theory of friction. The nature of the other, however, is not so explicable. This points to the existence of what Holm called the Y-term of friction, the nature of which has yet to be satisfactorily explained.

Bending of a Cantilever Plate Supported From an Elastic Half Space..61—APM-11...By N. C. Small, Assoc. Mem. ASME, University of Pittsburgh, Pittsburgh, Pa. 1961 ASME Applied Mechanics Summer Conference paper (in type; to be published in **Trans. ASME—J. Appl. Mech.;** available to April 1, 1962).

A solution is obtained for an infinitely long cantilever plate supported from an elastic half space. The junction conditions between the elasticity approach for the half space and the classical plate theory (no-shear) approach for the plate are based upon the use of assumed equilibrium surface tractions for the half space. The formal Fourier integral results for the example of a concentrated free-edge load are evaluated using an IBM 704 computer. The correlation with the deflection results of a steel model test is shown to be very good. The small deviations from the theoretical values are primarily due to shear effects in the model. It is also shown that, except for very stubby plates, it is sufficiently accurate to neglect the shear effects along the half space, and to assume that the rotation is proportional to the moment in the conventional "Winkler" sense.

Propagations of Elastic Waves Generated by Dynamical Loads on a Circular Cavity..61—APM-12...By A. C. Eringen, Purdue University, Lafayette, Ind. 1961 ASME Applied Mechanics Summer Conference paper (in type; to be published in **Trans. ASME—J. Appl. Mech.;** available to April 1, 1962).

The Fourier-transform technique has been employed to solve the exterior elasto-dynamic problem concerning the region outside a circular cavity in a plane elastic body. The normal and tangential tractions acting at the surface of the circular cavity are prescribed as arbitrary functions of the polar angle, θ, and the time, t. The case of impact, blast, and moving loads are studied in detail.

Extensional Vibrations of Elastic Orthotropic Spherical Shells..61—APM-14... By W. H. Hoppmann II, Mem. ASME, Rensselaer Polytechnic Institute, Troy, N. Y.; and W. E. Baker, Mem. ASME, Aberdeen Proving Ground, Aberdeen, Md. 1961 ASME Applied Mechanics Summer Conference paper (in type; to be published in **Trans. ASME—J. Appl. Mech.;** available to April 1, 1962).

The extensional vibrations (momentless) of spherical shells of elastic orthotropic material have been studied theoretically. Equations of motion have been derived and solved. The principal directions of the elastic compliances are assumed to be along parallels of latitude and along meridians. In addition to the case of orthotropic shells of uniform thickness, the analysis may be applied in the case of shells with stiffeners attached. Special consideration is given to the isotropic shell as a limiting case of the orthotropic shell.

Viscoelastic Effects in Birefringent Coatings..61—APM-23... By P. S. Theocaris, Mem. ASME, Athens National Technical University, Athens, Greece; and C. Mylonas, Mem. ASME, Brown University, Providence, R. I. 1961 ASME Applied Mechanics Summer Conference paper (in type; to be published in **Trans. ASME—J. Appl. Mech.;** available to April 1, 1962).

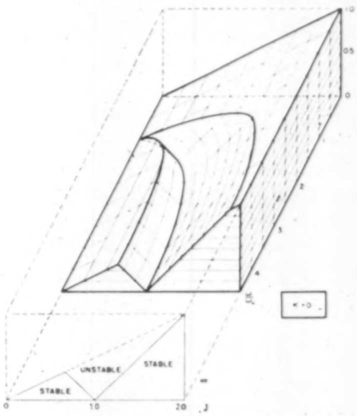
The method of birefringent coatings for the determination of elastic and plastic surface strains of opaque bodies like metals assumes perfect elasticity of the coating material. In reality the coating, assumed much softer than the metal, presents the problem of a general viscoelastic layer under prescribed boundary displacements (at the metal-plastic interface). As already shown, this problem is greatly simplified for isotropic linear viscoelastic coatings, for small strains, for a linear law of strain birefringence, and for interface displacements expressed as a product of a function of space co-ordinates by a time function.

The obviously advantageous stress-strain-optical linearity was experimentally verified in pure and in plasticized epoxy resins which make the best coatings. Tests were carried out in uniaxial loading and in shear, in creep, as well as in relaxation. The main conclusion is that the pure epoxy resins show negligible inelasticity, and the plasticized have a linear photo viscoelastic behavior. Explicit laws were fitted to the creep and relaxation curves. A method is suggested for studying interface strains which are not a product function, as e.g., elastic-plastic straining.

Whirling of Unsymmetrical Rotors..61—APM-10... By P. J. Brosens and S. H. Crandall, Mem. ASME, Massachusetts Institute of Technology, Cambridge, Mass. 1961 ASME Applied Mechanics Summer Conference paper (in type; to be published in **Trans. ASME—J. Appl. Mech.;** available to April 1, 1962).

A study is presented of the motion of overhung rotors rotating at constant speed, having unequal diametral moments of inertia, and supported pivotally with unequal stiffnesses about mutually perpendicular stationary axes. Gyroscopic coupling is included throughout.

It is found that some rotors are dynamically unstable above a certain speed and that some of these may return to a stable condition at a sufficiently high speed depending on the particular magnitudes of the gyroscopic coupling and the inertia inequality. The effect on rotor stability due to nonrotating inequality in the supporting stiffness is studied. For small stiffness inequality this effect is only of second order; as the stiffness inequality is increased, new unstable speed regions may appear. Test results on an unsymmetrical rotor verify the theoretical predictions.



Stable and unstable speed regions in the case of equal supporting stiffnesses of overhung rotors having unequal diametral moment of inertia (61—APM-10)

Thermodynamic Analysis of the Darcy Law..61—APM-5... By R. G. Mokadam, Indian Institute of Technology, Kharagpur, S. E. Ry., India. 1961 ASME Applied Mechanics Summer Conference paper; (in type; to be published in **Trans. ASME—J. Appl. Mech.;** available to April 1, 1962).

The Darcy law is used extensively to describe the flow of fluids through porous media. According to this law the fluid flow is linearly dependent upon the pressure gradient and the gravitational force. The proportionality factor is generally known as the permeability of the porous medium. The Darcy law cannot be derived from the Navier-Stokes equation since this equation includes terms which characterize the fluid only. With the help of nonreversible thermodynamics it is possible to develop a general equation of motion of a fluid through a porous body, and obtain the Darcy law as a special case of such an equation.

Bending of a Thin Cylindrical Shell Subjected to a Line Load Around a Circumference..61—APM-15... By H. R. Meck, Pratt & Whitney Aircraft, Connecticut Aircraft Nuclear Engine Laboratory, Middletown, Conn. 1961 ASME Applied Mechanics Summer Conference paper (in type; to be published in **Trans. ASME—J. Appl. Mech.;** available to April 1, 1962).

An analysis is developed for bending of a thin circular cylindrical shell under a varying radial line load distributed around the circumference at the center section. The problem is solved by reducing the eighth-order differential equation of thin-shell theory to two approximate fourth-order equations. Deflections, bending stresses, and membrane stresses are evaluated. Both simply supported and clamped ends are considered.

The Stresses in an Elastoplastic Bar Subjected to a Sudden Change of Surface Temperature..61—APM-16... By E. W. Parkes, University of Leicester, Leicester, England. 1961 ASME Applied Mechanics Summer Conference paper (in type; to be published in **Trans. ASME—J. Appl. Mech.;** available to April 1, 1962).

An analysis is given for the stress history in an elastoplastic bar subjected to a sudden change of surface temperature. The type of behavior is found to depend on the ratio of thermal strain (αV) to yield strain (σ_y/E). For $E\alpha V/\sigma_y < 1$, the stresses are entirely elastic. For $1 < E\alpha V/\sigma_y < 2.04$ there are two transient zones of compressive yielding. For $2.04 < E\alpha V/\sigma_y < 4.4$ there are two transient zones of compressive yielding and two enduring zones of tensile yielding. For $E\alpha V/\sigma_y < 4.4$ there are two transient zones of compressive yielding, one transient zone of tensile yielding, and two enduring zones of tensile yielding. The investigation is restricted to the range $0 \leqslant E\alpha V/\sigma_y \leqslant 5$ and the particular case $E\alpha V/\sigma_y \rightarrow \infty$. Detailed solutions are given for $E\alpha V/\sigma_y = 1, 2, 3, 4, 5$, and ∞.

Gas-Lubricated Cylindrical Journal Bearings of the Finite Length, Part I—Static Loading..61—APM-17... By B. Sternlicht, Assoc. Mem. ASME, General Electric Company, Schenectady, N. Y. 1961 ASME Applied Mechanics Summer Conference paper (in type; to be published in **Trans. ASME—J. Appl. Mech.;** available to April 1, 1962).

Numerical solutions are presented of

the Reynolds equation for finite length gas-lubricated cylindrical journal bearings under static loading (this corresponds to a load of constant magnitude and direction with respect to the bearing). It is shown that the incompressible results are but only limiting cases to the more general compressible solutions. The results of the two solutions are dovetailed together through the use of two dimensionless parameters: the inverse of the Sommerfeld number and the compressibility number. Comparisons of the iterative solutions and the first-order perturbation and the "linearized ph" methods are made. The advantages and disadvantages of these methods of analysis are discussed.

Theoretical Pressure Distribution in Journal Bearings..61—APM-20... By Kichiye Habata, Sato Agricultural Machine Manufacturing Company, Shimane Prefecture, Japan. 1961 ASME Applied Mechanics Summer Conference paper (in type; to be published in **Trans. ASME—J. Appl. Mech.;** available to April 1, 1962).

By assuming oil viscosity constant, Reynolds' equation for journal bearings has been solved in a manner similar to Hill's method. Two approximate solutions using E. O. Waters' method and Ritz's method have been added. Numerical computations have been carried out for a centrally supported 120-deg bearing with a unity slenderness ratio. Isobarriers have been determined from the pressure distributions. In order to show a justification for assuming the viscosity constant, the Reynolds equation was solved for the infinitely long bearing with variable viscosity, and the solution compared with that of Sommerfeld.

Bending and Stretching of Certain Types of Heterogeneous Aeolotropic Elastic Plates..61—APM-21... By E. Reissner, Mem. ASME, and Y. Stavsky, Massachusetts Institute of Technology, Cambridge, Mass. 1961 ASME Applied Mechanics Summer Conference paper (in type; to be published in **Trans. ASME—J. Appl. Mech.;** available to April 1, 1962).

The class of plates with which this paper is concerned includes as an important special case plates consisting of two orthotropic sheets of equal thickness which are laminated in such a way that the axes of elastic symmetry enclose an angle $+\theta$ with the x, y-axes in one sheet and an angle $-\theta$ in the other sheet. For plates of this type there occurs a coupling phenomenon between in-plane stretching and transverse bending which does not occur in the theory of homogeneous plates and which has not been considered in earlier work for such plates. The results are illustrated by solutions for two plate problems.

Torsion of Sandwich Plates of Trapezoidal Cross Section..61—APM-22... By Shun Cheng, University of Wisconsin, Madison, Wis. 1961 ASME Applied Mechanics Summer Conference paper (in type; to be published in **Trans. ASME—J. Appl. Mech.;** available to April 1, 1962).

A system of suitable stress-strain relations as well as equations of equilibrium are derived and solved for the torsion of sandwich plates of trapezoidal cross section. The facings are treated as isotropic solid membranes of equal thickness while the core is of such a nature that its stiffness associated with plane-stress components are negligibly small.

It is felt that the torsional stiffness presented in this paper is sufficiently accurate for the majority of sandwich panels in use such as stabilizing fins and control surfaces of airplanes. For such panels, the slope of the facings (α) is usually less than 30 deg and the constructions are of such a nature that renders the basic assumptions applicable. The range of applicability of the solution could be somewhat increased if thin-plate theory were used in regard to the facings.

ASME TRANSACTIONS

Journal of Applied Mechanics

The September, 1961, issue of the Transactions of the ASME—*Journal of Applied Mechanics* (available at $1.50 per copy to ASME Members, $3 to nonmembers)—contains the following:

Technical Papers

- Investigation of Flat-Plate Hypersonic, Turbulent Boundary Layers With Heat Transfer, by Eva M. Winkler. (60—WA-205)
- On the Parametric Excitation of Pendulum-Type Vibration Absorber, by Eugene Sevin. (61—APMW-4)
- Mixing of Compressible Fluids, by E. D. Kennedy. (61—APMW-3)
- The Laminar Boundary Layer on a Hot Cylinder Fixed in a Fluctuating Stream by R. J. Gribben. (60—WA-203)
- Diffraction of a Pressure Wave by a Cylindrical Cavity in an Elastic Medium, by M. L. Baron and A. T. Matthews. (61—APM-26)
- Whirling of Unsymmetrical Rotors, by P. J. Brosens and S. H. Crandell. (61—APM-10)
- Torsion of Sandwich Plates of Trapezoidal Cross Section, by Shun Cheng. (61—APM-22)
- Natural Frequencies of Vibration of Fixed-Fixed Sandwich Beams, by M. E. Raville, En-Shiuh Ueng, and Ming-Min Lei. (61—APMW-2)
- Combined Stresses in an Orthotropic Plate Having a Finite Crack, by D. D. Ang and M. L. Williams. (61—APM-19)
- The Effect of a Rigid Elliptic Inclusion on the Bending of a Thick Elastic Plate, by Fu Chow. (61—APM-13)
- An Addition to the Theory of Whirling, by T. R. Kane. (61—APMW-1)
- Bending of a Cantilver Plate Supported From an Elastic Half Space, by N. C. Small. (61—APM-11)
- The Elastic, Plastic Bending of a Simply Supported Plate, by G. Eason. (61—APM-18)
- Bending and Stretching of Certain Types of Heterogeneous Aeolotropic Elastic Plates, by E. Reissner and Y. Stavsky. (61—APM-21)
- Bowing of Cryogenic Pipelines, by W. G. Flieder, J. C. Loria, and W. J. Smith. (61—APMW-7)
- Dynamic Membrane Stresses in a Circular Elastic Shell, by R. G. Payton. (61—APMW-10)
- An Extension of Duhamel's Analogy to Plasticity, by S. A. Murch. (61—APM-9)
- Bending of a Thin Cylindrical Shell Subjected to a Line Load Around a Circumference, by H. R. Meck. (61—APM-15)
- The Stresses in an Elastoplastic Bar Subjected to a Sudden Change of Surface Temperature, by E. W. Parkes. (61—APM-16)
- Plastic Stress-Strain Relationships—Further Experiments on the Effect of Loading History, by J. Parker and J. Kettlewell. (61—APM-24)
- On the Dynamic Behavior of a Frank-Read Source, by J. D. Campbell, J. A. Simmons, and J. E. Dorn. (60—WA-204)

Brief Notes

- On Similarity Solutions for Free-Convection Flow Past Flat Plates, by Pau-Chang Lu.
- A Single Formula for the "Law of the Wall," by D. B. Spalding.
- On Classical Normal Modes of a Damped Linear System, by Morris Morduchow
- On Certain Invariants of Symmetric Cartesian Tensors, by Dave Pandres, Jr.
- On the Occurrence of Nodal Patterns of Nonparallel Form, by N. J. Huffington, Jr.
- Three-Dimensional Bending of a Ring on an Elastic Foundation, by D. A. Rodriguez.
- Pressure-Flow Characteristcs of Randomly Oscillating Pipe Flows, by C. L. Tien and J. H. Leinhard.

Discussion

Discussion of previously published papers by Myron Tribus; K.-T. Yang; W. W. Short; Paul Seide and V. I. Weingarten; F. Freudendstein and G. N. Sandor; W. J. Carter and F. C. Liu; M. A. Goldberg, V. L. Salerno, and M. A. Sadowsky.

Book Reviews

Stresses in Shells
Control of Multivariable Systems
Dynamic Behavior of Thermoelectric Devices
Electronic Processes in Solids
Problems of the General Theory of Oscillations and of Chronometry

Process Industries

An Axial-Flow Porous Plug Apparatus.. 61—SA-22...By R. C. King, Mem. ASME, New York University, New York, N. Y.; and J. H. Potter, Mem. ASME, Stevens Institute of Technology, Hoboken, N. J. 1961 ASME Summer Annual Meeting paper (in type; to be published in Trans ASME—J. Engng. for Indus.; available to April 1, 1962).

The design of an apparatus for determination of Joule-Thomson coefficients is presented. An axial flow porous plug is utilized and the downstream flow is so arranged that one concentric flow path serves as a heat shieled for the other. This guard-ring principle, together with virtual elimination of radiation and convection heat transfer, reduces the heat leakage that has been associated with previous axial-flow designs.

A prototype was constructed and tested with gaseous nitrogen. The Joule-Thomson coefficients obtained agree, in the range 2–20 atmosphere and 50–150 C, within one per cent with published values.

Availability List of Unpublished ASME Papers

A NUMBER of papers and reports, not preprinted or published, were presented at ASME Meetings. Manuscript copies of these papers are on file for reference purposes in the Engineering Societies Library, United Engineering Center, 345 East 47th Street, New York 17, N. Y. Photostatic copies of these unpublished papers may be secured from the Library at the rate of 50 cents per page. Microfilm copies are available at a cost of $2 for 40 pages or less.

The following papers recently have been placed on file in the Engineering Societies Library:

1961 American Power Conference

Topographic Influences on the Behavior of Stack Effluents, by E. W. Hewson, E. W. Bierly, and G. C. Gill

1961 Lubrication Symposium

Lubrication With Condensed Gases at Cryogenic Temperatures, by G. S. Reichenbach and D. E. Foraker

1961 Summer Annual Meeting

Planning in a Specialty Business, by G. Gregory

Residual Stresses From Explosive Forming, by E. K. Henriksen

Chemical Milling State of Art Approaches State of Science, by J. E. Trankla

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Mollier Diagrams
Structural Mechanics in the USSR 1917–1957
Engineering Thermodynamics
My Life and Times as a Physicist

Journal of Basic Engineering

The September, 1961, issue of the Transactions of the ASME—*Journal of Basic Engineering* (available at $1.50 per copy to ASME Members, $3 to nonmembers)—contains the following:

Flow Models in Boundary-Layer Stall Inception, by V. A. Sandborn and S. J. Kline. (60—WA-149)

Generalization of a Class of Solutions of the Laminar, Incompressible Boundary-Layer Equations, by W. O. Winer and A. G. Hansen. (60—WA-159)

Particle Trajectories in a Gas Centrifuge, by A. R. Kriebel. (60—WA-158)

Nonsteady Discharge of Subcritical Flow, by George Rudinger. (60—WA-152)

Effects of Inlet Conditions of Performance of Two-Dimensional Subsonic Diffusers, by B. A. Waitman, L. R. Reneau, and S. J. Kline. (60—WA-143)

Inlet and Exit-Header Shapes for Uniform Flow Through a Resistance Parallel to the Main Stream, by Morris Perlmutter. (60—WA-160)

The Influence of Tip Clearance on Stall Limits of a Rectilinear Cascade of Compressor Blades, by Ghassan Khabbaz and Yasutoshi Senoo. (60—WA-163)

Theory of Scale Effects on Cavitation Inception on Axially Symmetric Bodies, by R. Oshima. (60—WA-136)

Scale Effects on Cavitation, by J. W. Holl and G. F. Wislicenus. (60—WA-151)

Note on Observations of Cavitation in Different Fluids, by L. R. Sarósdy and A. J. Acosta. (60—WA-83)

The Jet-Flap Compressor Cascade, by E. F. Brocher. (60—WA-165)

The Hydraulic Analogy Applied to Nonsteady, Two-Dimensional Flow in the Partial-Admission Turbine, by H. K. Heen and R. W. Mann. (60—WA-168)

Transport Processes Involving a Moving Rotation Disk in a Low-Density Gas, by S. L. Soo. (60—WA-154)

Analog Computer Solution of a Complex Transient-Hydraulic Problem in the Power Industry, by E. H. Taylor, A. Reisman, E. C. Deland, and H. H. Baudistel. (60—WA-5)

Regulation of a Hydraulic Turbine Calculated by Step-by-Step Method, by Ignacy Swiecicki. (60—WA-128)

Pressure Surges Following Water-Column Separation, by J. T. Kephart and Kenneth Davis. (60—WA-120)

The Magnus Effect: A Summary of Investigations to Date, by W. M. Swanson. (60—WA-150)

Ejector-Nozzle Flow and Thrust for Choked Flow, by H. E. Weber. (60—WA-155)

Technical Brief

Energy Theory of Half-Frequency Whirl, by Richard Elwell.

ASME Order Forms

Technical Papers

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Note: No digests are made of ASME papers published in full or condensed form in MECHANICAL ENGINEERING.

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COMMENTS ON PAPERS

The Engineer's Debt to Management

To the Editor:

For some time now I have been plagued with the feeling of progressive inferiority as I read the titles of or listen to papers presented at Society meetings, but at last L. F. Urwick's article[1] has restored my confidence.

It is not only the professor who aspires to being "one of half a dozen people who know more about some tiny island of a subject than anyone else . . . and have his books reviewed in learned journals by the other five." Engineers by the hundreds seem bent on making their work appear so complicated that only another who has gone down precisely the same path of research can understand it.

I would endorse heartily Mr. Lorsch's recommendation[2] for the presentation of papers, and even suggest that the same principles apply to the preparation as well. Surely it is a greater achievement to impart understanding of a complex subject to persons unfamiliar with it than it is to argue technicalities with other superspecialists in a particular field.

R. L. Marcotte.[3]

What's in a Name?

To the Editor:

It is to be hoped that many engineers, and especially many engineering educators, will read Philip Sporn's article.[4]

Mr. Sporn seems to see more clearly than many educators themselves what is the difficulty in the colleges: The faculty have become so absorbed in their science-oriented subject matter that they completely forget to make the students understand that the primary function of the engineer is to serve the people, and that solving scientific and technical problems is really a means to that end.

LETTERS

The editorial,[5] also in the same issue of Mechanical Engineering, stresses the need for better nomenclature. With this must go a clearer definition of what the engineer is.

Recently I visited a superior private preparatory school in the East. The principal told me, "Frankly, engineering has become auxiliary to science; an engineer is the scientist's Man Friday. We urge our ablest students to study the sciences."

Perhaps some of our important engineers should prevail upon a national figure like von Karman to write an article for the *Saturday Evening Post* or *Look* in which he clearly distinguishes between the scientists and the engineer. He would be objective as he is recognized as both scientist and engineer. He might resolve some of the confusion which results because many engineers reach into the sciences, and many scientists reach into engineering.

C. J. Freund.[6]

Decimal Inch Versus Metric System

To the Editor:

The June, 1961, issue of *Civil Engineering* carried an article[7] proposing that we adopt the decimal foot in place of a switch to the metric system.

While there are some arguments to be made for this suggestion, it would carry considerable complications for mechanical engineers since the author seems to have forgotten all about screw threads—which is the mistake also made by most proponents of a change to the metric system.

To be realistic about this, let us take a look at what would happen if we adopted his proposal of dropping all dimensions except his decimal foot. This would change a $^{5}/_{16}$-18 bolt to an 0.015625-216 bolt if we hold the same diameter and thread—as would be necessary to retain its interchangeability. Then, the change from inches to feet would reach makers and users of sheet metal and steel tubes just as they are in the process of dropping thickness gages in favor of decimals of an inch. Thus the popular 0.020-in. aluminum sheet would become 0.00167-ft sheet and the commonly used 0.019-in. corrugated steel sheet would be 0.00158-ft sheet instead. Rather a clumsy notation which would most likely end up by a change in thickness to permit dropping some of the figures—thus introducing still another change.

Since the inch is already decimalized below unity, with the "mill" and the "microinch," and some industries—like the automobile and aircraft—use nothing but inches, why not continue with the inch? We could extend this decimalization upward with the minimum of complications by calling ten inches a "short foot," 100 inches a "long yard," and 100,000 inches a "long mile." This would leave mechanical engineering virtually unchanged although it would affect civil engineering usage. But it would have the enormous advantage that everything is still interchangeable. We would not require new bolts, screws, and nuts as if we adopted metric, yet we would have all of the advantages of a decimal system.

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[1] L. F. Urwick, "The Engineer's Debt to Management," Mechanical Engineering, vol. 83, March, 1961, pp. 35–37.

[2] H. G. Lorsch, "Presenting a Paper? Here's How," Mechanical Engineering, vol. 83, March, 1961, p. 94.

[3] Senior project engineer, plant engineering department, Apparatus and Optical Division, Eastman Kodak Company, Rochester, N. Y. Mem. ASME

[4] Philip Sporn, "The Case for the Engineer," Mechanical Engineering, vol. 83, June, 1961, pp. 42–44. *See also* "Letters," August, 1961, pp. 86–87.

[5] J. J. Jaklitsch, Jr., "What's in a Name?" (editorial), Mechanical Engineering, vol. 83, June, 1961, p. 41.

[6] Dean, College of Engineering, University of Detroit, Detroit, Mich. Fellow ASME.

[7] Bernard L. Weiner, "Decimal System, Yes; Metric System, No," *Civil Engineering*, June, 1961, vol. 31, pp. 58–59.

Archibald Black.[8]

Fresh Water From Salt Water

To the Editor:

The April, 1961, issue of Mechanical Engineering included, on pages 102 and 103, comments by E. D. Howe and J. T. Chambers on Allen Cywin's paper[9] followed by the author's closure. Mr. Cywin's closure contained an inaccurate statement relating to repayment of the capital cost of California's $1.75 billion State Water Resources Development System which I know you and Mr. Cywin will wish to correct.

The comments by Mr. Howe and Mr. Chambers included this sentence: "In California, for example, irrigation use represents 80 to 90 per cent of the demand, and costs which would render demineralized water usable for irrigation will be much lower than those permissible in industrial and domestic applications."

Responding to this comment Mr. Cywin stated, in part: "California may indeed be a largely agricultural water-consuming state. However, the entire state population (largely municipal in number) was recently asked to vote on a mammoth $1.75 billion general obligation bond issue for an additional water supply. All of the taxpapers will retire those bonds and thus the capital cost of the project will never be reflected by the water rates chargeable to water customers."

It is true that the $1.75 billion general obligation bond issue is backed by the credit of the State. However, under the contracting principles which were adopted by Governor Edmund G. Brown and the Department of Water Resources, the project's water and power rates are based upon repayment of all reimbursable capital costs with interest over the repayment period and payment of operating and maintenance charges on a current basis.

These principles, and numerous additional provisions designed to insure that the project will be a self-liquidating undertaking, are embodied in repayment contracts which have been executed by the department with the Metropolitan Water District of Southern California and the San Bernardino Valley Municipal Water District. These contracts have established the standard form of contract that will be executed with all other agencies desiring service from the project.

The project is planned for an annual water delivery of 4 million acre-feet by the year 1990. More than half of this project demand will be for municipal and industrial use. Nearly half of the project demand will be south of the Tehachapi Mountains. It is estimated that about 200,000 acre-feet of the water delivered to Southern California will be for agricultural use. In the San Joaquin Valley the bulk of the water requirement will be agricultural.

William E. Warne.[10]

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[8] Engineer, PE, N. Y., Stafford Springs, Conn.

[9] Allen Cywin, "Fresh Water From Salt Water," Mechanical Engineering, vol. 82, October, 1960, pp. 57–62.

[10] Director, State of California Department of Water Resources, Sacramento, Calif.

Notes on
Books Received
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REVIEWS OF BOOKS

Mechanical Wear: Wear, Frettage, Fitting, Cavitation, and Corrosion

Handbook of Mechanical Wear: Wear, frettage, fitting, cavitation, corrosion

Charles Lipson and L. V. Colwell, editors. The University of Michigan Press, Ann Arbor, Mich., 1961. Cloth, 6 /· × 10 in., figs., tables, summary, references, 469 pp., $20.

Reviewed by Earle Buckingham[1]

This Handbook is a comprehensive summary of much research that has been conducted in this field. The combinations of circumstances that may exist in any particular case are so varied that study—as well as experience—must be brought to bear in order to analyze any specific example. Professor Lipman states in the Introduction: "No general rule holds for all manifestations of wear. It is affected by a variety of conditions, such as the type and mode of loading, speed, quantity and type of lubricant, temperature, hardness, surface finish, presence of foreign materials, and the chemical nature of the environment."

To this could be added the conditions existing at the first operation or "running-in" of the mating surfaces. This is a factor that is often overlooked. Two duplicate units, with different histories of initial operation, can show widely different conditions of wear in similar service. With a careful running-in, many of the asperities of the machined surface can be removed with minimum damage and this will give a much smoother surface finish for the later operation. Where the materials are unhardened and plastic, this initial operation will cold-work the surface material, improve the smoothness of the surfaces, and develop a stronger and more wear-resistant surface material than existed on the original machined components.

Part one is the Introduction where, for purposes of discussion, it is suggested that one logical method of classifying wear would involve the nature of the contacting surfaces as follows: Metal-against-metal, metal-against-nonmetal, and metal-against-fluid.

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[1] Gear consultant, Belmont 78, Mass. Fellow ASME.

The following terms are suggested for classifying the different types of wear:

1 Galling, scuffing, scoring, and seizing. These are adhesive types of wear and involve the shearing of the microwelds forms between the surface asperities that carry the actual load.

2 Abrasion. This exists when foreign matter of various kinds are present between the sliding surfaces.

3 Pitting. This may be of many different types, and appears to be the results of cyclic repetitions of contact stresses between the two surfaces.

4 Frettage. This appears to be set up by minute reciprocating motions between the wearing surfaces. One common manifestation of this is between the bore of a component and its shaft when restrained by a single key. This permits a slight racking action with frettage that starts on the surfaces opposite the key.

5 Cavitation erosion. This involves the presence of a fluid. It occurs in propeller blades, diesel engine-cylinder liners, turbines, and pumps.

6 Galvanic corrosion. This is a complex phenomenon, and has an important influence on the choice of metals in contact.

Part two deals with the fundamental aspects of wear. Chapter 1 discusses the Compatibility of Metal Pairs. It gives the following rules:

"Two metals can slide on each other with relatively little scoring if both of the following conditions are met:

"1 The metals must be insoluble in each other, with neither metal dissolving in the other nor forming an alloy with it.

"2 At least one of the metals must be from the B-subgroup; i.e., the elements to the right of the nickel-lead-platinum column in the periodic table, Fig. 1."

Results of tests are given for various combinations of materials.

Table I. Soluble pairs with poor score resistance.

Table II. Insoluble pairs, neither from the B-subgroup, with poor score resistance.

Table III. Insoluble pairs, one from the B-subgroup, with fair to good score resistance.

Table IV. Soluble pairs with fair or good score resistance.

Table V. Insoluble pairs, one from the B-subgroup, with poor score resistance.

These tables show that the criteria are wrong only nine times in 123 tests, or about 7 per cent of the time.

Chapter two deals with the sliding characteristics of metals at high temperatures. Fig. 1 is a schematic diagram of the test apparatus. Eight charts are given showing the relationships of the coefficients of friction at different temperatures, and one for the changes in the coefficients of friction in relation to the number of cycles. Several illustrations of the test materials after the tests are also included. The summary of results is as follows:

"1 Extremely high friction, surface damage, and greater wear results with metals sliding against themselves at a temperature where the metal softens appreciably, if no protective oxide is formed.

"2 If an oxide is formed, the galling tendency is reduced and effective sliding results as long as the oxide film adheres to the surface.

"3 If the formed oxide is hard, the sliding is essentially oxide on oxide. However, if the oxide is removed from the surface, abrasive wear results.

"4 If a soft oxide is formed on the surface, a beneficial effect is achieved by preventing surface damage and reducing abrasive wear. However, too much soft oxide can increase the rate of wear.

"5 There is a relation between the friction properties of alloys and that of the major constituents. The limited data indicate that a reduction in friction occurs at a temperature sufficient to promote oxidation of the least oxidation-resistant component. With several alloys (such as cobalt, copper, and iron) this reduction takes place at low temperatures."

Chapter three covers friction, wear, and surface damage of metals as affected by solid surface films. This is limited to the conditions of boundary lubrication, and gives results of tests on the performances of several surface films. The naturally formed surface films are tested over a range of sliding velocities zero to about 5000 ft/min. Data are also given for the rate of wear of several materials and for the influence of temperature on the results. These films include the naturally formed oxide films, those formed by chemical reaction of surfaces, and some solid lubricants. An illuminating summary of results brings out the complex interaction of the many different factors involved.

Chapter four gives a summary of over 30 years of testing to obtain experimental load-stress factors for wear load values under rolling action alone, and for the combined rolling and sliding such as exists with gear-tooth action. This includes the method of tests on cylindrical samples and the analysis of the test results.

Part three covers the nature of the physical breakdown of the surface material: Pitting, scoring, and spalling.

Chapter five discusses the subsurface fatigue, and shows several illustrations of failures under various conditions of loading.

Chapter six discusses the resistance of materials to rolling loads, and is devoted primarily to the conditions on the elements of rolling bearings.

Chapter seven is devoted to the pitting of gear teeth. It contains many illustrations of different conditions of surface failure and also fatigue fractures of the gear teeth.

Chapter eight deals with the importance of surface temperature to surface damage. "The above examination is admittedly abbreviated. Its intent is to impress upon the engineer the importance of increased studies on the effect of surface temperatures not only on scoring and pitting, but also on wear of various forms. Such studies, combined with further studies on the coefficient of friction, will bring about increased understanding of surface damage, which in turn will result in increased efficiency in the attention to surface-damage problems."

Part four discusses many of the problems of corrosion. Chapter nine deals with galvanic corrosion. It includes an extended chart of experience with a wide range of galvanic couples of common metals and alloys tested in sea water.

Chapter ten gives the test results of accelerated cavitation research. The behavior of various metals and alloys subjected to cavitation in different test liquids is reported.

Chapter eleven deals with fretting and fretting corrosion. It appears to be caused by a small amount of sliding such that no lubricating film can be formed or sustained. Results of tests are shown, and some preventative measures are suggested.

Chapter twelve discusses Corrosion at high temperatures. This is most often encountered in internal-combustion engines. "The problem of high-temperature corrosion of metals and metal alloys is mainly one of gross oxidation. The theory controlling such oxidation processes is well developed but because actual corrosion problems become so complex they are usually solved empirically rather than analytically."

Part five is devoted to abrasion. Chapter thirteen discusses the abrasive wear of metals. It treats the various types of abrasive wear which occur at normal temperature as a result of dynamic contacts between metallic surfaces and abrasive particles or fragments. These are classified into three distinct types, as follows: Gouging abrasion, usually with impact; high-stress or grinding abrasion; and low-stress scratching abrasion or erosion.

It deals with the wear on scrapers, on the interior surfaces of a ball mill, on a feed screw for sand, and so on. Tables of rates of wear of various materials under the different types of abrasive wear are included.

Chapter fourteen treats the subject of wear resistance. The discussion is confined to the wear resistance of metallurgical materials, and various surface protections, and the relative wear resistance of materials.

Part six is devoted to wear-resistant materials. Chapter fifteen is devoted to modern high-carbon ferrous metals for resistance to surface damage.

Chapter sixteen covers wear resistance of cast-iron components.

Part seven deals with manufacturing processes. Chapter seventeen describes residual stresses in metal cutting.

Part eight is a Summary: A condensed account of the material in this book under review.

No text can ever be an adequate substitute for actual experience: Either that of conducting actual tests or of trying to analyze the cause and effect of actual examples of excessive wear in service. The knowledge and understanding acquired by such experiences can never be conveyed completely to someone else.

This handbook, however, together with its extensive references to many other papers on the subject, will prove an invaluable source of information and help to anyone who is faced with the problem of trying to explain why destructive wear exists on some used, or abused, component of a mechanism. The problem of wear, as well as that of the poor, will probably be always with us.

BOOKS RECEIVED IN LIBRARY

Centrifugal Pumps

By Igor Karassik and Roy Carter. 1960, F. W. Dodge Corporation, New York, N. Y. 488 p., $7\frac{1}{4} \times 10\frac{1}{4}$ in., bound. \$15.75. A guide, for the centrifugal pump user, to the most satisfactory combination of system design and equipment selection, and to achievement of maximum service with minimum maintenance and unscheduled outage for installed equipment. Structural details, component parts, construction materials and such aspects as conditions of service and performance characteristics are given in general for centrifugal pumps, and also in particular for such specific types as vertical, regenerative, and self-priming pumps. Detailed attention is given to pump controls. A general data section presents valuable data required for engineering pumping installations and for analyzing the performance of existing units. Complex technical explanations and theoretical discussions have been avoided in the interests of providing useful and practical information on all aspects of the use of centrifugal pumps.

Creative Engineering Design

By Harold R. Buhl. 1961, Iowa State University Press, Ames, Iowa. 195 p., $7 \times 9\frac{1}{4}$ in., bound. \$3.95. This book whimsically draws on an intriguing variety of sources, from *Machine Design* to the *Saturday Evening Post* and "Alice in Wonderland" for quotations and cartoons to support the sound suggestions and techniques presented. The aim of the book is to develop in the reader a capacity to design. The author makes a keen analysis of the particular challenge to imagination and creativity which distinguishes design problems from other engineering problems, and, effectively pointing out why some designs are not creative, he describes the particular traits of the creative design engineer and his techniques. The various steps in the process of creative design are carefully presented, from recognition and definition of the problem to evaluation and presentation of the solution. Somewhat of a "popularization," with an unusual format, this book offers a stimulating and refreshing viewpoint.

Design of Worm and Spiral Gears

By Earle Buckingham and Henry H. Ryffel. 1960, The Industrial Press, New York, N. Y. 450 p., $6\frac{1}{4} \times 9\frac{1}{4}$ in., bound. \$15. Intended to demonstrate the value of all-recess-action design principles, this book provides a step-by-step guide to the design of worm and spiral gear drives with all-recess action, pointing out how all-recess action design concepts can improve load-carrying and life capacity, and the other benefits of improved design. Also presented are certain basic principles and practices which enter the successful design and manufacture of all types of gears and gear drives.

Determination of the Mechanical and Technological Properties of Metals

By B. M. Gliner. 1960, Pergamon Press, Inc., New York, N. Y. 160 p., $5\frac{1}{2} \times 8\frac{3}{4}$ in., bound. \$8.50. This translation of the second (1959) edition of a Russian work gives a brief description of the methods used in the Soviet Union for determining the principal mechanical and technological properties of metals. For each method are given definitions of the characteristics to be determined, the expressions from which the basic strength properties are to be calculated, the form and dimensions of the testpieces, and the test procedure used, with diagrams of the relevant instruments and equipment. Section one describes, in this manner, the mechanical testing of metals; section two, methods of determining the mechanical properties of weld metal and welded joints; and section three, determination of the technological properties of metals, such as machinability, weldability, and hardenability.

Dynamic Management in Industry

By Raymond Villers. 1960, Prentice-Hall, Inc., Englewood Cliffs, N. J. 516 p., $6\frac{1}{4} \times 9\frac{1}{4}$ in., bound. \$10. This is a study of the application of scientific methods to industrial management, and of the function and scope of management science within the organizational structure of the industrial enterprise. Existing concepts of management are reviewed in terms of their historical development, the various theories of organization are discussed, and the concepts of functional decentralization and of functionalization of planning and control are all studied in detail. The point of view is dynamic, considering the introduction of the principles in a going business, and actual case studies are presented to illustrate the principles discussed.

Electronics in Engineering

By W. Ryland Hill. Second Edition. 1961, McGraw-Hill Book Company, Inc., New York, N. Y. 340 p., $6 \times 9\frac{1}{4}$ in., bound. \$8. As in the first edition, this is an introduction to electronic devices and their properties for engineering and science students. The primary change in this second edition is the introduction of semiconductor devices, and discussing circuit analyses for vacuum and for semiconductor devices together. Topics covered include the diode, rectifier and amplifier circuits, resonance and tuned amplifiers, amplitude modulation and demodulation, solid-state switching devices, photosensitive devices, feedback, oscillators, transducers, transistors, the analog computer and the cathode-ray oscilloscope.

Fundamentals of Aerodynamic Heating

By Robert Wesley Truitt. 1960, The Ronald Press Company, New York, N. Y. 257 p., $6\frac{1}{4} \times 9\frac{1}{4}$ in., bound. \$10. This introduction to aerodynamic heating is based on senior-graduate level lectures given at the Virginia Polytechnic Institute, and constitutes a detailed development of the theoretical background of laminar and turbulent layers, and their relation to skin friction and heat transfer. The exposition begins with basic concepts and fundamental equations, and then discusses the laminar and the turbulent boundary layer, theoretical skin friction and heat transfer, and approximate methods for the solution of laminar boundary layers. The final chapters deal with low-density flow parameters, slip flow, free molecule flow, heat transfer and mass-transfer cooling in the stagnation region, and the calculation of skin temperature. Simple kinetic analyses of viscosity and heat conduction are given in appendixes.

Information Retrieval and Machine Translation, Part 1. (Advances in Documentation and Library Science, Vol. 3)

Edited by Allen Kent. 1960, Interscience Publishers, Inc., New York, N. Y. 686 p., $6\frac{1}{4} \times 9\frac{1}{4}$ in., bound. \$23. The first part of a two-part volume recording the papers and discussion of the International Conference for Standards on a Common Language for Machine Searching and Translation, sponsored by the Rand Development Corporation and Western Reserve University in September, 1959. Sixty papers were presented by representatives of ten countries, and 21 of the papers, and discussions on them, are published in this volume.

Introduction to Nuclear Science

By Alvin Glassner. 1961, D. Van Nostrand Company, Inc., Princeton, N. J. 213 p., $6\frac{1}{4} \times 9\frac{1}{4}$ in., bound. \$3.75. This elementary survey of nuclear science and its impact upon the other physical and natural sciences is based on a summer course given for high-school science teachers by personnel of the Argonne National Laboratory. The lectures reflected the activities of the laboratory, and the material in this book, taken from these lectures, is kept as nontechnical as possible, eliminating complicated mathematics, and emphasizing recent developments and experimental and laboratory aspects of nuclear science. The 12 chapters deal with the nuclear atom and nuclear particles, natural radioactivity, nuclear phenomena such as spin, parity, stability and models, nuclear reactions, radiation and its detection, biological aspects, and effects on materials, high-energy accelerators, reactors and the processing of reactor fuels, and the metallurgy of uranium. The final 20 pages describe specific experiments in nuclear science.

Introduction to the Kinematic Geometry of Gear Teeth

By Allan H. Candee. 1961, Chilton Company, Philadelphia, Pa. 204 p., $6\frac{1}{4} \times 9\frac{1}{2}$ in., bound. $12.50. The author has been actively engaged in the development of modern gear-cutting machines and tools for more than 40 years. In this book he draws on his experience to discuss the theory of the transmission of motion by gear teeth, and applications of principles. He limits his treatment to contact between profile curves in cross sections of gear teeth, employing two-dimensional geometry, a treatment which applies mainly to gears on parallel axes. General principles and general ideas of tooth design are covered first. Then the author carefully examines spur gears, fillet curves, and involute curves, devoting most space to the last. In each case he covers layout and construction of profiles, cutting and generating of teeth, and other such pertinent matter. The final two chapters deal with profile errors, modification, and variations, and with involute approximations.

It's the Law!

By Bernard Tomson. 1960, Channel Press, Great Neck, N. Y. 436 p., $5\frac{3}{4} \times 8\frac{1}{2}$ in., bound. $7.50. Based on a monthly column written by Judge Tomson over a period of years for *Progressive Architecture,* this book aims to furnish to the architect, engineer, and contractor a basic appreciation of some of the more important legal problems with which they may become involved. It furnishes the answers to some specific legal questions, contains a special section of standard legal forms, and discusses statutes regulating professional practice, organization and business problems, employment relations, rights and liabilities, and restrictions upon the use of property. There is also a useful index of cases cited throughout the text.

Large Elastic Deformations and Non-Linear Continuum Mechanics

By A. E. Green and J. E. Adkins. 1960, Oxford University Press, New York, N. Y. 348 p., $6\frac{1}{2} \times 9\frac{1}{2}$ in., bound. $8.80. In a previous book (Theoretical Elasticity, 1954), Mr. Green collaborated in presenting the general theory of elasticity for finite deformation, with applications for isotropic incompressible materials. The present book concentrates on subsequent developments, including the strain energy function for the basic crystal classes; stress-strain relations for orthotropic and transversely isotropic materials; curvilinear aeolotropy and exact solutions of the finite theory, mainly for aeolotropic bodies, development of the theory of plane strain; plane stress and the membrane theory of thin shells; a method of successive approximation; and the reinforcement of elastic materials by systems of thin flexible inextensible cords. The final chapters deal with the theories of thermoelasticity and elastic stability for finite deformation, and recent developments in nonlinear continuum mechanics.

Linguistics and Engineering Studies in the Automatic Translation of Scientific Russian into English, Phase 2

Published 1960 by the University of Washington Press, Seattle, Wash. 492 p., $8\frac{3}{4} \times 11\frac{1}{4}$ in., bound. $10. This special technical report details the machine translation (MT) research undertaken by the University of Washington, Seattle, under the sponsorship of the Rome Air Development Center (RADC), from June, 1958, to October, 1959. The first phase of this research concluded on June 30, 1958, and was described in a report published at that time. The first (linguistic) section of this second report outlines the history of MT, lists MT-linguistic publications, and discusses the problem of idioms, lexicography, and syntactic research, in four papers. The simulated machine translation of 111 selected Russian scientific texts is presented in an appendix to this section. Section two contains three papers and two appendixes discussing applications of electronic computers and readers in MT, and the logical programming research carried out in this project.

Problems in Basic Operations Research Methods for Management

By Randolph W. Cabell and Almarin Phillips. 1961, John Wiley & Sons, Inc., New York, N. Y. 110 p., $5\frac{1}{2} \times 8\frac{1}{2}$ in., bound. $3.95. The exercises and problems in this book were developed for graduate courses in operations research methods at the University of Virginia. The topics covered include mathematical programming methods, inventory models, sequencing models, queuing problems, problems requiring Monte Carlo analysis, replacement and assignment problems, and problems in the design of experiments and the analysis of variants. In terms of numerical complexity and required level of mathematics, most of the problems are simple, elementary knowledge of differential and integral calculus, probability and sampling theory, and exponential distributions will be helpful, but is not prerequisite.

Properties and Structure of Polymers

By Arthur V. Tobolsky. 1960, John Wiley & Sons, Inc., New York, N. Y. 331 p., $6 \times 9\frac{1}{2}$ in., bound. $14.50. This book attempts to outline the basic principles of the mechanical behavior of polymers in terms of molecular architecture and dynamics. Selection of topics for discussion is based on the author's research experiences. Included are chapters on polymer physics, the elasticity, viscosity, and viscoelasticity of polymers, chemical stress relaxation, and polymerization equilibria. Special data are given in the ten appendixes, including the partition function, configurational entropy of a gas, the equation of state for molecular crystals, and maximum relaxation times.

Propulsion and Auxiliary Power Systems, Vol. 2 of Ballistic Missile and Space Technology

Edited by Donald P. LeGalley. 1960, Academic Press, New York, N. Y. 441 p., $6\frac{1}{4} \times 9\frac{1}{2}$ in., bound. $9. The Fifth Symposium on Ballistic Missile and Space Technology, sponsored by the USAF, Space Technology Laboratories, and the Aerospace Corporation, brought together more than 1000 U. S. A. scientists and engineers at the University of Southern California in August, 1960. The Proceedings, to be published in four volumes, will include the 74 unclassified papers presented at the symposium. This second volume of the Proceedings contains 15 papers, which are grouped in topical sections dealing with propellant technology, ion propulsion, heat transfer and materials, and auxiliary power systems.

Ballistic Missile and Space Technology, Vol. 1, 3, and 4

Edited by Donald P. LeGalley. 1960, Academic Press, Inc., New York, N. Y. 3 volumes, $6\frac{1}{4} \times 9\frac{1}{4}$ in., bound. $9 each. Volume 1, "Bioastronautics and Electronics, and Invited Addresses," deals with the human element in space technology, inertial guidance and control, space communication, computers, computing and data reduction, and telemetry. The seven invited addresses are surveys of general aspects of the subject—international space competition, the challenge and future of man in space, U.S. achievements, and the management of space programs. Volume 3, "Guidance, Navigation, Tracking, and Space Physics," covers those subjects, and includes papers also on space trajectories. Volume 4, "Re-entry and Vehicle Design," deals with the materials and engineering mechanics of re-entry, and discusses design from the standpoints of performance analysis, system description, and operational considerations.

Structural Mechanics in the U.S.S.R., 1917–1957

Edited by I. M. Rabinovich. 1960, Pergamon Press, New York, N. Y. 431 p., $5\frac{3}{4} \times 9$ in., bound. $8. This translation is a review of the results of research carried out in the Soviet Union in the field of structural mechanics from 1917 to 1957. The nine chapters deal with two and three-dimensional elastic bar systems; thin-walled members; elastic foundations; the theory of plates; shells, and other thin-walled spatial structures; dynamic analysis of structures; plasticity theory; extremum and variational principles in the theory of structures; and pressure and resistance of granular media; and the analysis of retaining walls and subterranean structures. A bibliography simplified by translation of titles, and transliteration of author-names and sources accompanies each chapter. Also included is the Russian alphabet, the transliteration used in this work, and a list of common Russian abbreviations met in bibliographies.

Successful Managerial Control by Ratio-Analysis

By Spencer A. Tucker. 1961, McGraw-Hill Book Company, Inc., New York, N. Y. 434 p., $6\frac{1}{4} \times 9\frac{1}{4}$ in., bound. $11. The purpose of this book is to introduce and explain the "MC" concept—a concept and technique for managerial control of a business which reduces company data to significant ratios, and interrelates their movements. This concept was developed by the author, and has been applied over the past 20 years to companies ranging in sales size from $250,000 to $80 million per year. The author shows how company operating figures and statistics can be manipulated and interpreted in the interests of management control and company life and growth, explaining in detail methods of compiling and dealing with 429 specific ratios which evaluate specific facts of the economy. Many practical examples of the application of the MC concept are given.

Thermal Reactor Theory

By A. D. Galanin. 1960, Pergamon Press, New York, N. Y. 412 p., $5\frac{1}{2} \times 8\frac{3}{4}$ in., bound. $15. This translation reflects the work of Soviet scientists in the development of thermal reactor theory prior to the Second Geneva Conference in 1958. Knowledge of the elements of nuclear physics and kinetics theory is assumed. The ten major sections of the book deal with: diffusion and slowing down of neutrons; the critical size of a reactor; multiplication, slowing-down, and diffusion in a homogeneous medium; heterogeneous reactors; perturbation theory; the isotopic composition of nuclear fuel; delayed-neutron kinetics; and the Boltzmann equation.

Ultrasonics and Its Industrial Applications

By O. I. Babikov. 1960, Consultants Bureau Enterprises, Inc., New York, N. Y. 224 p., $6\frac{1}{4} \times 9\frac{1}{4}$ in., bound. \$9.75. This is a translation of a Moscow State Press publication of 1958. After a brief review of the development of ultrasonic technology, the propagation, generation, and absorption of ultrasonic oscillations are described in detail. The remainder of the book deals with specific ultrasonic techniques: in flaw detection, investigation of the microstructure of metals, physical-chemical analysis, machining hard and brittle materials, aluminum soldering and plating, and cleaning operations. The final chapter discusses the metallurgical effects of ultrasonic processing, and the utilization of these effects in improving the structure of a metal.

Aerodynamik des Flugzeuges, Vol. 2

By H. Schlichting and E. Truckenbrodt. 1960, Springer-Verlag, Berlin, Germany. 485 p., $6\frac{1}{2} \times 9\frac{1}{4}$ in., bound. DM 52.50. This second volume of a textbook on aircraft aerodynamics deals with the theory of the wing of finite-span in both incompressible and compressible flow, the aerodynamics of the body, and of the tail unit, as well as with the mutual dependence of the different parts of the plane. The appendix includes sketches of numerous aircraft construction-types plus the appropriate geometric magnitudes in order to assist the reader in mathematical problem solving. There is an extensive bibliography.

Analytical Techniques for Non-Linear Control Systems

By John C. West. 1960, D. Van Nostrand Company, Inc., Princeton, N. J. 223 p., $5\frac{1}{2} \times 8\frac{3}{4}$ in., bound. \$5.75. Dr. West, of Queen's University of Belfast, writes primarily for control engineers requiring engineering analytical techniques for analysis of the performance of closed-loop automatic control systems, when amplitude nonlinear elements dominate the performance. He selects a few techniques which are of general application, and illustrates their principles by extending the implications of specific examples to general application. He discusses in this manner the phase-plane method, harmonic analysis, the use of probability theory, and the equivalent gain technique.

Applied Radiation and Radioisotope Test Methods

Published 1960 as ASTM Special Technical Publication No. 268 by the American Society for Testing Materials, Philadelphia, Pa. 112 p., $6\frac{1}{4} \times 9\frac{1}{4}$ in., bound. \$3.75. The 11 papers published in this volume examine the applications of methods involving radioisotopes to established industrial test methods, with the ultimate goal of adoption of these methods as routine test procedures. The test areas involved include diesel locomotive ring wear, grain boundary segregation, soil density and moisture content, hydrocarbon-sulfur analysis, magnesium oxide content in Portland cement, mixing uniformity, metal film thickness, permeability of organic sheet materials, and uniformity of coated fabrics.

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Bibliographic Survey of Corrosion, 1956

Published 1960 as Publication 60-12 by the National Association of Corrosion Engineers, Houston, Texas. 240 p., $8\frac{1}{2} \times 11$ in., paper. No price given. This is the seventh in a series which covers corrosion literature for the period 1945–1956, inclusive. This volume includes abstracts of almost all of the articles published during 1956 that have come to the attention of the association, and also 58 abstracts of articles published in prior years which have come to the attention of NACE since publication of the 1954–1955 Bibliographic Survey.

Boolean Algebra and Its Applications

By J. Eldon Whitesitt. 1961, Addison-Wesley Publishing Company, Inc., Reading, Mass. \$6.75. George Boole (1815–1864) developed the system of algebra now bearing his name as the first, and revolutionary, application of a tool of numerical calculation to the development of a system of logic. Boolean algebra now has two other important applications: in treatment of the combination of sets of elements under the operations of intersection and union of sets; and as the foundation for the theory of probability. This book, developed from notes for a course at Montana State College, is designed to introduce the subject on a level which will make it available even to those with rather limited mathematical background, and to examine each of the applications in enough detail so that the reader will gain an appreciation of the scope and usefulness of the subject. It can also serve as a background for specialized courses in any of the major areas of application.

The Brittle Fracture of Steel

By W. D Biggs. 1960, Pitman Publishing Corporation, New York, N. Y. 420 p., $5\frac{3}{4} \times 9$ in., bound. \$15. Dr. Biggs (Cambridge University) writes to reconcile the differing approaches to the problem of brittle fracture by the engineer, the metallurgist, and the physicist, and to emphasize those metallurgical features which determine whether the material will behave in a ductile or a brittle manner. This is neither a source book nor a textbook on the plastic deformation and fracture of engineering materials. It is an attempt to promote a clearer understanding of the material, design, and fabrication problems involved in the brittle behavior of metals. The author discusses service failures, mechanical aspects of flow and fracture, the effect of external conditions and of such fabrication process as welding, the nucleation and propagation of fracture, mechanical tests and correlation of test results, and residual stresses.

Contemporary Problems of Metallurgy

Edited by A. M. Samarin. 1960, Consultants Bureau, New York, N. Y. 530 p., $6\frac{3}{4} \times 10$ in., bound. \$16. Commissioned by "Acta Metallurgica" and the National Science Foundation, and edited by Dr. Chalmers of Harvard University, this is a translation of a 1958 USSR Academy of Sciences publication. The first few pages contain a tribute to the Soviet metallurgist, I. P. Bardin. The remainder of the book contains 43 papers by authors prominent in the metallurgical field in the USSR and Mainland China. Topics covered in these papers include description of plans of metallurgical plants, the metallurgy of ferrous and of nonferrous metals (including production of raw materials and of fuel), pressure working of metal, and the "science of metals"—papers on such subjects as martensitic transformation, the structural theory of creep, and methods of increasing the strength, hardness, and wear properties of metals.

An Engineering Approach to Gyroscopic Instruments

By Elliott J. Siff and Claude L. Emmerich. 1960, Robert Speller and Sons, Publishers, Inc., New York, N. Y. 120 p., $6\frac{1}{4} \times 9\frac{1}{4}$ in., bound. \$7.50. The authors write for engineers, at a level intermediate between elementary explanations of gyroscopic effects and complicated mathematical derivations. In the first chapter, they discuss the fundamental principles of gyroscopic motion and the basic elements of primary applications, such as the gimballed gyroscope. The remaining three chapters examine applications, in three separate categories: Basic gyro configurations such as displacement, rate, and integrating gyros; special gyro designs such as floated, air and fluid bearing, vibrating rate and particle gyros, with details on magnetic and electrostatic suspensions; and special instrument gyroscope applications—free, vertical, and directional gyros, and gyro platforms. "A comprehensive review of the principles and general features of existing instruments," according to Dr. C. S. Draper, of M.I.T.

Engineering Economics and Practice

By Max J. Steinberg and William Glendinning. Published 1961 by the author, William Glendinning, 5123 Bell Boulevard, Bayside 64, N. Y. This is the 1961 edition of a useful compilation which briefly surveys the subject content of the New York State Professional Engineer examinations, Part 3—Professional Engineering. Topics covered include compound interest formulas, depreciation, comparison of alternate proposals, calculating a prospective rate of return, replacements, and costs. Problems and answers for exams in this section held from July, 1957, through June, 1960, are given.

Kempe's Engineers Year-Book for 1961, Vol. 1 and 2

Edited by C. E. Prockter. 66th Edition. 1961, Morgan Brothers (Publishers) Ltd., London, England. 2 vol., $4\frac{3}{4} \times 7$ in., bound. 87s 6d. This compendium of the modern practice of civil, mechanical, electrical, marine, gas, aeronautical, mining, and metallurgical engineering contains revised information in almost every one of its 84 sections. It is a useful compilation, with an extensive index in volume 2, though its wide coverage lessens its specificity, making it more useful in general reference than for the specialist.

Current Engineering Events, News, and Comment

E. S. NEWMAN
News Editor

THE ROUNDUP

U. S. Team Visits Automatic Control Facilities—Educational and Industrial—in Japan

On behalf of the Japanese National Committee of Automatic Control (part of the Science Council of Japan), Prof. Kankuro Kaneshige, chairman of the committee and Atomic Energy Commissioner, invited Prof. Rufus Oldenburger,[1] Mem. ASME, of Purdue University, to take a team of outstanding automatic control specialists from the United States to Japan, and to act as chairman of the team.

The purpose of the visit, which took place May 9–30, 1961, was to see laboratories, plants, and universities throughout Japan, and meet automatic-control engineers and scientists in the interest of bringing the United States and Japan closer together in the area of automatic control. The trip started in Tokyo and ended in Tokyo, with stops at Nagoya, Kyoto, Osaka, Kokura, and elsewhere.

The team was composed of the following professors: Gilbert H. Fett, electrical engineering, University of Illinois; John E. Gibson, Assoc. Mem. ASME, electrical engineering, Director of the Information and Control Systems Laboratory, Purdue University, and team reporter; O. J. M. Smith, electrical engineering, University of California, Berkeley, team photographer; and Rufus Oldenburger, Mem. ASME, mechanical engineering, Director of the Automatic Control Center, Purdue University, team chairman. Men from industry included: S. W. Herwald, Mem. ASME, vice-president in charge of engineering, Westinghouse Electric Corporation; Joel Hougen, technologist, systems section, Monsanto Chemical Company; A. F. Sperry, Fellow ASME, chairman of the board, retired, Information Systems, Inc., and engineering consultant; W. S. Tandler, research engineer, Arthur D. Little, Inc.; and H. W. Ziebolz, Mem. ASME, assistant to the vice-president of engineering, General Precision Equipment Corporation. The professors on the team gave lectures at the Universities of Tokyo, Nagoya, Kyoto, and the Institutes of Technology of Kyushu and Tokyo.

Among the team were members of all of the societies belonging to the American Automatic Control Council; namely, The American Society of Mechanical Engineers, the Institute of Radio Engineers, the American Institute of Chemical Engineers, and the Instrument Society of America.

General Host: Prof. Kankuro Kaneshige, Japan Atomic Energy Commissioner (University of Tokyo, retired) and Japanese National Committee on Automatic Control chairman.

Tokyo hosts included: Prof. T. Nakada, chairman, Tokyo Institute of Technology; Prof. S. Fujie, Tokyo University; Prof. Y. Ikibe, Tokyo Institute of Technology; Prof. T. Isobe, Tokyo University; Prof. K. Izawa, Tokyo Institute of Technology; Dr. K. Morita, Tokyo Institute of Technology, Prof. A. Nomoto, Chuo University; Prof. Y. Oshima, Tokyo University; and Prof. M. Terao, Tokyo University.

Prof. T. Yamamoto, Nagoya University, was chairman of the local host committee.

Prof. Y. Sawaragi was chairman of the local host committee of Kyoto University.

S. Sasabuchi, president of Asahi Glass Company, Yawati, Kyushu, was chairman of the local host committee.

Automatic Control in Japan

An excellent balance has been attained between Japanese automatic control and the needs of the Japanese economy. With industry shattered by World War II, automatic control has been developed on a broad basis to achieve a rate of growth which since the war has been one of the highest in the world, reported Rufus Oldenburger.

Power and materials are expensive in Japan. In these areas some outstanding examples of the use of automatic control have been observed in Japan, developed to conserve these resources. This is in contrast to the United States where automatic control has been applied extensively, not only to conserve power and materials, but to reduce the need for men, and to cut labor costs by increasing the productivity per man. Automatic control has not been used by Japanese industry on the same scale as in the United States because of the low cost of labor and the availability of a large pool of industrious and skilled workers, and because of other reasons. Until now Japan has had to concentrate its available funds on licensing arrangements, but recently she has had surplus funds to devote to research. Japanese workers are essentially hired for lifetime jobs. Japanese industry wishes to preserve them. Knowing it must meet future competition of foreign industry, it is interested in introducing more and more automation now where it can be economically justified.

Various devices such as aircraft and missiles which could not operate without automatic control, and which are supported by the military in the United States, are not produced in any quantity in Japan. Japan has not had the benefit of extensive government support of research on such devices. Because of this and the needs of the Japanese economy, automatic control in general in the United States is several years ahead of Japan. However, the recent vigorous development of automatic control by Japanese instrument manufacturers, the high scientific level of its automatic control specialists, the excellent awareness of advanced work going on elsewhere in the world, the many confident and competent brilliant engineering teams, and the modern laboratory and plant facilities being built and planned in Japan indicate that the gap will be rapidly narrowed.

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[1] Professor of Mechanical Engineering and Director of Automatic Control Center, School of Mechanical Engineering, Purdue University, Lafayette, Ind. Mem. ASME.

More study of system dynamics by users is needed in Japan to broaden the application of its instrument industry. The equipment supplied by the government to universities and the enlargement of faculties will provide a needed stimulus to the growth of the automatic control field. We hope that this support will be increased. New facilities must be provided in the universities on an extended scale to house control equipment, a real need that will have to be met soon by the Japanese.

The Japanese have developed some excellent electronic components and measuring devices of their own design, such as tunnel diodes, parametrons, and Hall effect transducers. Further interchange of know-how between Japan and the United States, as well as other countries, regarding these and other aspects of instrumentation should be beneficial to all countries involved.

Average growth rates of 15 per cent or 20 per cent a year, one-hundredfold increases in gross annual production by some companies in ten years and increases of 400 per cent in two years in the numbers of research workers employed by some companies make Japan a major force in the world of automatic control. She is an important friend of the United States.

Research in Automatic Control in Japanese Universities

An over-all impression of University research in automatic control as reported by J. E. Gibson[2] follows. The theoretical work is of high quality and usually exhibits a solid mathematical base. Experimental verification has in the past been carried out only at the cost of severe effort. Even today, adequate laboratory equipment is not always available. One example comes to mind of a professor having to construct his own XY recorder in order to proceed with his experimental program. As in the United States, industry does not always seem to have been aware of their responsibility to encourage University research by donating equipment and instruments but happily some progress seems to have been made on this front.

Within the past few years an entirely new attitude seems to have developed in industry on the support of research in the physical sciences. This has had the transient effect on the universities of reducing their staff of young researchers. However, the long term effect could be excellent if the universities are able to meet their new competition as they seem to be doing.

American team visits automatic control facilities (industrial and educational) in Japan. Front row, **left to right:** Joel Hougen, O. J. M. Smith, Rufus Oldenburger (chairman of the team), G. H. Fett, and Albert Sperry. Back row, **left to right:** J. E. Gibson, W. S. Tandler, S. W. Herwald, and H. W. Ziebolz.

Research in automatic control in Japan seems to be more closely tied to physical reality and practical production problems than has become the fad in the United States. The Japanese universities have not reached the point of indulging in the luxury of theory for theory's sake to quite the extent that is apparent in American journals, for example.

Radio-Television Industry in Japan

Within the rapidly expanding Japanese economy, S. W. Herwald[3] observed, the radio-television industry has had perhaps the largest growth of all. In the period from January, 1958, to January, 1960, the percentage of households with television sets rose from 10.4 per cent to 44.7 per cent. It is estimated that in August, 1960, the figure was 54.5 per cent in the 28 larger cities in Japan. Japan is currently second only to the United States in percentage of households having television.

From the automatic-control standpoint the situation within the plants we visited and that which probably prevailed in those we did not see, was that there was really little automation used, Mr. Herwald pointed out. Instead they had modern plants with progressive assembly lines in which the times at each station appeared to be quite carefully balanced. With the Japanese labor rates at their current level, what was being done appears to be the correct balance between investment in capital and operating costs. Only an appreciable change in their labor rates would justify much investment in equipment to fully automate the assembly.

In neither the circuitry nor the manufacturing techniques did there appear to be anything new, he added. There did seem to be, however, considerable emphasis on quality, and the assembly lines contained long periods (many hours) of running and on-off time, prior to crating for shipment. With the unsaturated home market you would expect to see emphasis on production without innovation and this is precisely what appeared to be going on. This point was emphasized again in our discussion about color television. There appeared to be no effort, either now or contemplated in the near future, toward new color television schemes, but rather an adaptation of the shadow-mask color tube to a standard 17-in. Japanese cathode ray tube capability.

With Japanese current economics in which there are relatively low labor rates that continue to rise and expand consumer purchasing power, the emphasis of the placement of new investment capital is on new production facilities to produce more, rather than on research to produce fixed quantities at lower cost through automation, or to come up with radically new product substitutes through substantial research programs. The key question then to be answered is: "When these markets tend to saturate, as they certainly will some day and take the emphasis off facility expansion—will new funds then go into research and automation—and is there a capability to move in that direction from the current scientific base?" It is my opinion, Mr. Herwald concluded, that there does exist such a base in universities and government industrial laboratories and that when the emphasis comes in this direction, they will meet the challenge.

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[2] Professor of electrical engineering, Director of the Information and Control Systems Laboratory, Purdue University. Assoc. Mem. ASME.

[3] Vice-president—engineering, Westinghouse Electric Corporation, Pittsburgh, Pa. Mem. ASME.

Automation in the Heavy Industry

The Tokyo Gas plant, whose President is Mr. H. Hondo, reaches 1,590,000 customers in the Tokyo area with an annual gas production of 1,730,000,000 m^3. The number of employees, including engineers, clerks, and workers was about 8000 early in 1960.

We visited the largest and newest plant, Tokyo Toyosk, said Herbert Ziebolz,[4] which, like the Yawata Steel plant is one of those newly conceived giant installations which are courageously built into the sea on artificial ground.

With the limited available space for expansion on the Japanese mainland, this major venture in a geographical location of exposure to the dangers of earthquakes, typhoons, and tidal waves is in itself a symbol of the confidence and careful planning which is typical of modern Japan and is reflected in innumerable details of the plant facilities.

It is interesting to note that the rate of growth curves of the total Tokyo gas output, which was reduced from 400 billion m^3 in 1936 to about 100 in 1946, has reached the 1730 billion mark in 1960, as if the setback in expansion caused by World War II would not have occurred. In this respect its pattern of growth is duplicated by that of the Yawata Steel Company.

The plant instrumentation is as modern as that of its U. S. A. counterparts, with hydraulic regulators doing the heavy work on coke-oven mains, gas mixing, and compressor control stations.

The Btu content is maintained through a centralized mixing station—using calorimixers and calorimeters for monitoring the proportioning of oil gas, water gas, and coke-oven gas.

A high speed (30 seconds lag) calorimeter was mentioned as one of the company's new original developments but was not seen in operation.

The panels which are well designed, and well built, provide plenty of space for graphic displays, and instruments are limited to those absolutely necessary.

The low power valve controllers are usually of the miniaturized type combined with recorders with a marked preference for electrical hardware.

The afore-mentioned statements and observations can be repeated verbatim with regard to the new Yawata Steel Company's Tobotu plant in Kyushu.

This plant was also recently completed on artificial land and shows the same almost grandiose layout and spacious planning as seen in the Tokyo Gas installation.

Its President is Mr. Arakazu Ojima, and its Director, Dr. Kamekichi Wada, gave us a report on the history of Yawata Steel and a briefing on the main points of interest of this particular plant, which is only two years old.

Dr. Yasuo Nozaka, Chief of Instrumentation, took our team through the coal blending center, the blast furnaces, the soaking pits, and the rolling mills.

Again, the same observations can be made as in the Tokyo Gas plant. The equipment used is up to the highest standards of present technology; the panels are well arranged with a generous allowance of uncommitted surfaces.

Surprising, in comparison to U. S. practice, is the number of people working in the control centers. Unfortunately, lack of time and the difficulties of communication prevented an explanation of their duties.

Of unusual interest was an energy flow center which acted as central control and monitoring headquarters for electrical, fuel, and production loads with sufficient provisions for expansion for future additions.

It is interesting to note that, in spite of the need for import of most of the raw material, i.e., coal and ore from abroad (U. S. A., Canada, India), Japan's steel industry is competitive on the world market. (80.4 per cent of scrap, 47 per cent of coal, and 85.4 per cent of ore is imported.)

This is only possible by the use of the most modern equipment with large capacity furnaces and as far advanced methods as the use of oxygen in the Voest System and on the blast furnaces with the 1500 tons/day blast furnaces pushed beyond its design and flow meter ranges to an output of 2500 tons/day.

The Blooming mill is expected to be automatically controlled by a punched card system by 1962. During the visit it was shut down due to their changing of rolls. Through better economy of operation, better equipment, and better automation the fuel consumption/ton of steel has dropped from 1.6 mill Kcal/ton in 1950 to 0.6 in 1960.

To increase the efficiency even further, 60,000 tons displacement ore carriers are now being built and one additional blast furnace is to be blown in 1961.

The control equipment like that of the gas plant is hydraulic for the heavy duty jobs of the coke ovens, mixing station, soaking pits with pneumatic and electronic controllers for temperature and low power level, small size control gear.

The soaking pit panels are installed in air-conditioned cubicles with ample space for servicing and additional instruments.

Having seen most of the Japanese steel mills and coke plants in previous years, said Mr. Ziebolz, it is possible to state that even the older installations compare favorably with equivalent U. S. A plants.

However, the two most recent plants we saw are like their foreign—including European—counterparts representing the best that is available anywhere in the world, and demonstrate extreme care in planning and selection of components within the tasks defined.

There are no frills, but what is needed is provided and of top quality.

Digital Computers and Data Processing in Japan

Status of Computers Severally. Progress in the past few years has been impressive and rewarding, observed A. F. Sperry.[5] The Japanese have not tried to overtake the U. S. and until recently concentrated most of their efforts on the "Parametron," a unique magnetic core, invented by Dr. Goto of Tokyo University. This was rather surprising to us in view of the tremendous transistor development in Japan, particularly in the radio field, but we were told again and again that until recently transistors were not considered reliable enough for computers.

Today, however, all the computers under development are transistorized, but generally are not as fast or sophisticated as new machines coming on the market in the U.S.

Business and Scientific Computers. At least eight Japanese companies have IBM licenses and four offer business and scientific computers for sale. Hitachi, Nippon Electric (NEC), Fuji Communication Apparatus, and Tokyo Shivaura Electric (Tosheda) are the leaders and all offer transistorized computers, all using "dynamic flip-flop" logic, except Tosheda, and having an average speed about ten times slower than the transistor computers introduced in the U.S. this year. Although they are gradually switching to ferrite core memory, most of them still use magnetic drums as the main memory with small core memory buffers.

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[4] General Precision Equipment Corp., Tarry town, N. Y.

[5] Engineering Consultant, Los Angeles, Calif. Fellow ASME.

Fugi still makes fast scientific computers using Parametrons in a serial-parallel logic that is extremely fast for this type of machine. Using a 6-megacycle carrier and a 100-kc clock, it multiplies in 40 microseconds which compares well with modern transistor machines, but its cost seems to be relatively high.

Of course, IBM dominates the market in sales, even though it imports practically everything, and most of the mechanical input-output equipment supplied by the Japanese manufacturers was IBM.

Matsushita, Mitsubishi, and Sony have computers under development, and Hokushin is concentrating on industrial computers and data loggers. Hokushin seems to supply magnetic drums to many of the business machine companies. We were impressed by their manufacturing techniques, and particularly their quality control and methods of balancing and their bearing construction, techniques which they borrowed successfully from their Gyro Compass Department.

Process Computers and Data Loggers. Few process computers have been built in Japan, in fact, the only actual installations seem to have been in the field of Electric Power Systems for load distribution. Here Hitachi and Fuji have combined digital computers and analog simulators in a few new installations.

The chemical and steel companies, as far as we could tell, have not done anything yet toward studying computer control and have left it up to the manufacturers and the universities, who are beginning a number of interesting projects. The Usev companies in Japan are so busy building new capacity to fulfill their swelling demand for products, they just have not taken time out for anything else, but it is quite evident that they are interested and will start work in this field soon.

The leading company in the field of data logging and process computing is the Hokushin Electric. They have developed several families of machines in the past few years, starting with all-relay logic and are now building completely transistorized and very modern machines that seem quite outstanding. They use high-speed reed-type relays for input switching and have a full line of transducers to connect most inputs to 0–10 volts d-c. They have their own high-impendence differential preamplifier for low level (T.C.) inputs.

They have shipped 100 of their machines since July, 1958, when they entered the field, a rather amazing record. Most of these were data loggers, but they have built five process compute-loggers and shipped three. The main memory of their present machine is magnetic core (about 500,000 bits) but their new model will use ferrite cores, with magnetic drum back-up, and should be an effective control computer.

Fuji, Hitachi, and Tosheda have produced modern data loggers, largely for process system work in rather small quantities.

Inspection Trips. The team was taken to 21 industrial plants and laboratories active in the manufacturing, use, development, or testing of controls for the communication, chemical, oil, gas, steel, electric power, railroad, automotive, electrical, and other industries. Allied equipment and automated lines also were shown. On each trip between cities and at each stop there were hosts who had planned for every need of the team. Luncheon and dinner meetings at which the members of the team had a chance to mix socially with representatives from industry, education, and government were arranged at all stops. Side trips to the Nikko shrine, Beppu, hot springs, and other tourist high-spots were intermersed throughout the trip so that the team not only saw Japan at work but also at play. The team returned to the United States unable to express in words the gratitude it felt for the marvelous hospitality shown to it in Japan. It is particularly proud of having been the first foreigners permitted to visit the Hitachi Central Laboratories which are the finest in Japan.

RESEARCH

Engineering and Medicine

A unique co-operative union between medicine and engineering has been established in a series of research projects conducted jointly by doctors from Highland View Hospital, Cleveland, Ohio, and professors from Case Institute of Technology. In the proposed study program physicians, biologists, engineers, psychologists, and mathematicians will pool their skills in the treatment of disease.

As part of the program, the two Case computers will be used to assist in complicated diagnosis of heart and similar diseases. In one major area of the program, the elements of systems engineering will be applied to the rehabilitation of persons who have suffered limitations on their activities as a result of disease or accident. In addition, electrical studies will be made of the relationship of the muscles and nerves in the human body. Computers also will be applied to the study of metabolism.

Other aspects of the research will be conducted by the Engineering Design Center at Case, where one project is an attempt to program an artificial arm splint that may allow a paralyzed patient or amputee to perform such simple actions as eating. Studies there also will concern the measurement and control of pressure applied to the body.

Epoxy Resin

An adhesive epoxy resin may become a leading product in the construction world of tomorrow through research at the University of Arizona's Engineering Experiment Station. The resin is stronger than steel studs when used to bond elements of bridges and buildings together.

Epoxy resins, first used as adhesives in the 1920's, are a family of chemicals made from petroleum derivatives. Proof of epoxy's adhesive strength has been demonstrated in the university's structural engineering laboratory. A 4 × 21-ft composite bridge beam was constructed of a 1050-lb steel beam affixed with epoxy to the bottom of a 4500-lb concrete slab. Hydraulic jacks, fixed to a steel frame surrounding the test beam, applied a load of 140,000 lb before the composite beam cracked. In other tests, precast concrete and steel beams and columns are being bonded together with epoxy as a potential substitute for pouring concrete into forms built around steel superstructures at construction sites.

Element 103

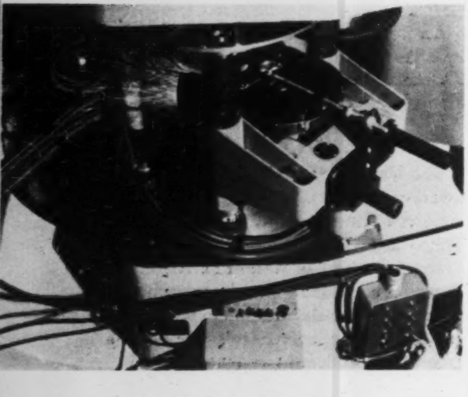
An isotope of element 103, discovered by a team of scientists at the Lawrence Radiation Laboratory, is the first to be discovered solely by nuclear methods.

Heat Transfer

The University of Michigan has been awarded a $199,000 contract to study the transfer of heat by boiling liquid metals. The award was made by the Aeronautical Systems Division of Wright Patterson Air Force Base. The 20-month program will include both analytical and experimental studies by the university's engineering faculty and student investigators.

Three-level, crescent-shaped structure houses the Thomas J. Watson Research Center of the International Business Machines Corporation. One of the world's largest research centers for the study of computer science, it accommodates 1500 scientists and supporting personnel for work on fundamental research preceding the development of new products. Designed by the late Eero Saarinen, the building is one of the latest IBM construction projects. Located at Yorktown Heights, N. Y., it is 40 miles north of New York City.

A nuclear research reactor so safe it is enclosed in glass is operating in the heart of the University of Washington campus in Seattle, Wash. The reactor's research operations can be viewed through a number of large picture windows. The reactor, known as the "Educator" type, was designed and built by American Machine & Foundry Company's Atomics Division at a cost of $500,000. The Educator is essentially a light-water and graphite-moderated reactor that uses water as both moderator and coolant. It has a large graphite prism surrounding the core proper, which is enclosed by a shield consisting of poured concrete and movable concrete blocks. This shielding prevents radiation streaming and keeps radiation levels on the operating floor well below tolerance.



The final stage in a new automatic pipeline welding process is demonstrated. The welding machine is shown clamped over the two pipe ends while its arc welder completes a swing around the pipes. The machine, developed by the Esso Research and Engineering Company, makes automatic pipeline welding in the field a reality since it welds without rotating the pipe. Two lengths of pipe can be welded 20 times faster than with present hand techniques. Only four motions are needed. The welder clamps itself in place, and an air-driven cutting wheel slices a sliver from each of the pipe ends in two circular sweeps. An arc welder follows in the track of the cutter, performing its job in two sweeps. An 8-in. pipe weld is completed in one minute.

Liquid metals to be studied include sodium, potassium, mercury, lithium, and rubidium. They have received attention lately for possible use in transferring heat from nuclear reactors because of their low vapor pressures at the high temperatures at which reactors operate. Steam at such temperatures would require heavy-walled containers.

Meteoroid Bumpers

Meteoroid bumpers to protect space vehicles against crippling damage or destruction in collisions with meteoroids are the subject of a new research study being conducted by General Dynamics/Convair. To establish design concepts, theoretical studies will be made of meteoroid impact in terms of mass and velocity, as well as experiments in hypervelocity impact of simulated spacecraft materials and structure.

Impact velocities approaching the lower range will be simulated by firing steel pellets weighing from a fifth to three-fourths of a gram at such materials as copper, aluminum alloys, magnesium alloys, titanium, and laminated and composite structures. The year-long study, an extension of work already done by Convair in hypervelocity impact and meteoroid protection concepts, is being conducted under a $54,000 NASA contract.

Supersonic Flight

A team comprising a human crew and a microminiaturized digital computer may fly the supersonic transport of the future, resulting in safety and economy as well as expanded available airspace for better traffic control.

This was revealed by Donald W. Richardson, a Hughes Aircraft Company engineer, at a symposium of the International Air Transport Association. He said that, with the supersonic transport, the airway structure of today in which airliners are restricted to designated air corridors would not be practical, and that completely automatic area navigation not only would provide more airspace, but would insure continual compliance to assigned ground tracks.

Most of the techniques and hardware needed to develop a central electronic management system (CEMS) for commercial supersonic aircraft already exist. CEMS proposes the use of a central airborne digital computer to integrate all or many of the varied functions now being performed on subsonic aircraft by a variety of subsystems.

25th Anniversary

Armour Research Foundation of the Illinois Institute of Technology is celebrating its 25th year of scientific research for industry and government. From a modest beginning in a few basement rooms in 1936, the foundation has grown to a seven-building complex and has become one of the largest research organizations in the world. The silver anniversary celebration will continue through May, 1962, and will include the dedication of a new $\$3^1/_2$-million chemistry research building and a \$1.2-million mechanics-research building extension. A special three-day symposium involving some of the world's best known scientists will be announced during the anniversary year.

Schooner for Marine Research

The Hopkins Marine Station at Stanford University will use a \$462,945 grant from the National Science Foundation to convert a two-masted schooner into a modern seagoing marine biological vessel. It is expected to be the world's largest sailing ship for scientific purposes. The schooner, named the *Pioneer*, was owned by George Vanderbilt, who gave it as a gift to the university. The grant provides for converting and outfitting the steel-hulled, 172-ft ship, and for maintenance and operation during a three-month shakedown cruise. Hydrographic, scientific, diving, photographic, and general equipment and supplies will be installed, making the vessel a completely operational biological laboratory ready for the shakedown cruise about six months after the onset of conversion activity.

Ionosphere Research

- The Pennsylvania State University will establish a small radio-astronomy observatory on the University Farms two miles northwest of the main campus. A 30-ft radio telescope or dish to receive radio signals from the sun will be the principal research instrument of the observatory, and will be installed early in 1962. It may help in understanding how changes in the sun affect the ionosphere, the blanket of charged particles beginning at about 30 miles' altitude that makes long-distance radio communication possible by reflecting broadcast radio waves back to earth. It is known that sunspots, flares, and other solar phenomena cause drastic changes in the ionosphere and in radio communications, although the cause-and-effect relationship is not yet understood.

The observatory will become an integral part of the university's Ionosphere Research Laboratory.

- Another project to be carried out in Penn State's Ionosphere Research Laboratory is the use of a new method of studying changes in the ionosphere during eclipses of the sun. The study will utilize an analog computer as a means of simulating the effect of the sun. Measurements of conditions in the ionosphere made throughout the world during periods of solar eclipse will be used to build up a set of equations for use in the computer program.

The program is part of the laboratory's long-range study of the effect of the sun on the ionosphere, and concerns the manner in which charged particles, or ions, recombine into neutral atoms or molecules during periods of darkness.

Aerospace Laboratory

Officials of The Franklin Institute Laboratories for Research and Development recently announced the creation of an Aerospace Laboratory. The laboratory will be part of the organization's mechanical and nuclear engineering division. It will be responsible for engineering projects dealing with air and space vehicles, and with simulators and other special research equipment needed in the nation's space program.

PEOPLE

Honors and Awards. Former President Herbert Hoover has consented to serve as Honorary Chairman of the dedication ceremonies of the new 20-story United Engineering Center. The dedication is scheduled for November 9th.

H. Russell Beatty, Mem. ASME, president of Wentworth Institute, Boston, Mass., received the \$500 James H. McGraw Award for outstanding contributions to technical institute education during the annual meeting of the American Society for Engineering Education held June 26–30 at the University of Kentucky.

Also presented at the ASEE annual meeting were: The Lamme gold medal to Olaf A. Hougen, Burgess Professor of Chemical Engineering at the University of Wisconsin; the George Westinghouse Award of \$1000 to David C. White, professor of electrical engineering at the Massachusetts Institute of Technology; the Vincent Bendix Award to Nathan M. Newmark, Mem. ASME, head of the department of civil engineering at the University of Illinois; and the \$1000 Curtis W. McGraw Research Award to William A. Nash, Mem. ASME, professor of engineering mechanics at the University of Florida.

S. C. Hollister, Hon. Mem. ASME, dean-emeritus of the school of engineering at Cornell University; and Vannevar Bush, Hon. Mem. ASME, honorary chairman of the Corporation of the Massachusetts Institute of Technology, were awarded honorary memberships in ASEE.

James H. Lansing, Mem. ASME, executive secretary, Ductile Iron Society, Cleveland, Ohio; and John S. Worth, Mem. ASME, metallurgical engineer, Bethlehem Steel Company, Inc., Bethlehem, Pa., have received awards of merit from the American Society for Testing Materials.

Jerome Lederer, Mem. ASME, managing director, Flight Safety Foundation, Inc., New York, N. Y., has been designated the Daniel Guggenheim Medal recipient for 1961 for his efforts to reduce the hazards of aviation.

J. W. Delleur, Assoc. Mem. ASME, associate professor of hydraulics at the school of civil engineering, Purdue University, Lafayette, Ind., has been chosen to receive the Freeman Fellowship for the academic year 1961–1962. He has been alloted \$3000 for research in hydraulics at the University of Grenoble, France.

Eugene C. Clarke, Mem. ASME, director, Chambersburg Engineering Company of Pennsylvania; and Henry A. Weyer, Mem. ASME, chief engineer, will receive Edward Longstreth Medals from The Franklin Institute on October 18. With Robert L. Alcorn, Jr., Chambersburg research engineer, who also will receive a Longstreth Medal, they are being honored for their modern method of forging metal into parts by use of the "Impacter," a horizontal forging hammer.

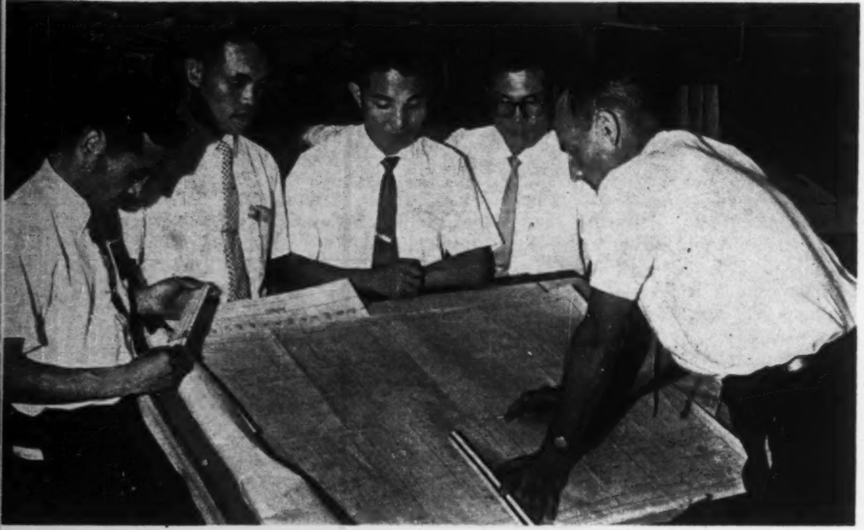
Leif J. Sverdrup, president and director of the engineering firm of Sverdrup & Parcel and Associates, Inc., received the 1961 NSPE Award for outstanding service to the engineering profession, during the society's annual meeting in Seattle, Wash., July 4–7.

Crawford H. Greenewalt of the E. I. du Pont de Nemours & Company, Inc., Wilmington, Del., has been designated the John Fritz Medal recipient for 1962 for his leadership in research.

Thomas Elmer Moon, an engineer who, after being stricken by blindness at the age of 56, developed a machine to help transplant corneas, will receive the 1961 ASME Holley Medal at the Society's Winter Annual Meeting in November.

Brigadier General Wilmot A. Danielson, USA (Ret.), is the 1961 recipient of the Marston Medal.

New Officers. Robert H. Roy, Fellow ASME, dean of the school of engineering



Four Korean Electric Company engineers, **left to right,** Lee Chul Ju, Hong Soon Kyoung, Shin Dong Bom, and Kim Kyong Soo, study the operating features of the new steam-electric plant to be erected at Kunsan, Korea. E. J. Cosgrove, **right,** is project manager for Burns and Roe, Inc., the consulting firm that is designing and engineering the station. The Korean engineers are undergoing a six-month training program in New York under the guidance of Burns and Roe as part of its contract to design the station.

at The Johns Hopkins University, is the new vice-president of ASEE. As vice-president, he will serve as chairman of ASEE's Engineering College Administrative Council.

ANTOINE M. GAUDIN, of the Massachusetts Institute of Technology, has been re-elected chairman of the Engineering Foundation, research department of the United Engineering Trustees, Inc. Three new directors, also elected, are HUGH L. DRYDEN, Fellow ASME, deputy administrator, National Aeronautics and Space Administration; LATIMER F. HICKERNELL, vice-president—engineering, Anaconda Wire and Cable Company; and ROY A. KINCKINER, deputy director, engineering Research Laboratory, E. I. du Pont de Nemours & Company, Inc., representing the American Institute of Chemical Engineers.

Appointments. EDWARD WENK, JR., Mem. ASME, former scientific consultant to Congressional committees, has been named executive secretary of the Federal Council for Science and Technology. Dr. Wenk, who is an authority on the design of submarines, will serve as a technical assistant to JEROME B. WIESNER, special assistant to the President for science and technology. Dr. Wiesner is chairman of the council.

MAURICE GOLDHABER has been appointed director of the Brookhaven National Laboratory. He has been chairman of the laboratory's physics department since 1960.

ARNE SIGVÅRD EKLUND, of Sweden, has accepted the appointment as director general of the International Atomic Energy Agency offered him by the agency's Board of Governors.

VICTOR F. WEISSKOPF became fourth director-general of the European Organization for Nuclear Research (CERN) on August 1. He joined CERN in September, 1960, as a member of the directorate for research.

Delegate. JOHN I. YELLOTT, Mem. ASME, director of the Yellott Solar Energy Laboratory, participated on behalf of the United States in the United Nations Conference on New Sources of Energy, in Rome, August 14 to 28, and the NATO Symposium on the Utilization of Solar Energy, in Athens, September 4 to 18. Mr. Yellott recently completed a five-year term as chairman of the ASME Solar Energy Applications Committee.

In India. Instructors from several American colleges have been selected to spend time working to develop engineering curriculums in Indian colleges as part of the U. S. International Co-operation Administration project there.

JOHN C. MILES, Mem. ASME, professor of mechanical engineering at the University of Illinois, is on assignment with ICA in India.

Spending the 1961–1962 school year in India are CHARLES A. GILPIN, Mem. ASME, mechanical engineering, and GERALD PICKETT, Mem. ASME, engineering mechanics, both of the University of Wisconsin. They will do teaching-research work at the Bengal Engineering College at Howrah, near Calcutta.

JOHN C. GEORGIAN, Mem. ASME, professor of mechanical engineering at Washington University, St. Louis, Mo., also will be at the Bengal Engineering College.

HERBERT H. ALVORD, Mem. ASME, University of Michigan professor of

Laurel van der Wal, **left,** head of bioastronautics at Space Technology Laboratories, Inc., Los Angeles, Calif., received the 1961 Society of Women Engineers Achievement Award at the society's banquet at the Statler-Hilton Hotel in Boston, Mass. She also has been named 1961 Woman Scientist of the Year by the Los Angeles Times and the Aerospace Medical Association Wives' Wing. Patricia Brown, **right,** Information Services Superviser for the Semiconductor-Components Division of Texas Instruments, Dallas, Texas, was elected president of the Society of Women Engineers at the conclusion of the society's annual convention on June 25. Miss Brown is a chemical engineer.

mechanical engineering, will spend the next year at the University of Roorkee, where he will be guest lecturer while setting up a mechanical analysis laboratory modeled after the one he established at the University of Michigan.

Campus Data. George F. Wislicenus, Fellow ASME, director of the Garfield Thomas Water Tunnel, a division of the Ordnance Research Laboratory at the Pennsylvania State University, has been named head of the department of aeronautical engineering at the university. He will continue in both positions.

Richard J. Grosh, Assoc. Mem. ASME, succeeded Paul F. Chenea, Mem. ASME, as head of the school of mechanical engineering at Purdue University on July 1, as announced by George A. Hawkins, Fellow ASME, dean of the school of engineering. Professor Chenea has been appointed vice-president in charge of academic affairs at the university.

George S. Reichenbach, Assoc. Mem. ASME, has been named to receive the Alfred Noble Prize for his paper "The Importance of Spinning Friction in Thrust-Carrying Ball Bearings." The paper was published in *Trans. ASME—Journal of Basic Engineering*, June, 1960. Mr. Reichenbach is on the staff of the mechanical engineering department at Massachusetts Institute of Technology.

William A. Lynch has been named head of the department of mechanical engineering at the Polytechnic Institute of Brooklyn. Prof. Lynch succeeds Charles T. Oergel, Mem. ASME, who will devote his time to teaching and research.

Travel. George Browne, Affiliate ASME, chairman of the EJC Committee on International Relations, has been on a two-month tour of Latin America in connection with McGraw-Hill publication interests since Aug. 15. He is expected to develop recommendations to strengthen participation of American engineers in the industrial development of Latin America. His plans included consultations with officials of the Pan American Federation of Engineering Societies (UPADI) on EJC's international programs, and with Puerto Rican engineering societies and Brazilian engineers. Mr. Browne is editor of *Industria*, McGraw-Hill International Corp., New York, N. Y.

Josef Wischeidt, Jr., secretary of the EJC Committee on International Relations, traveled to Paris, France, to discuss EJC co-operation with officials of UNESCO. He also is executive secretary of the U. S. Committee of the International Association for the Exchange of Students for Technical Experience (IAESTE) and will confer with French, Austrian, and German representatives of the committee with a view toward increasing U. S. participation in the program.

MEETINGS OF OTHER SOCIETIES

• IN THE UNITED STATES

October 16–18

The Magnesium Association, 17th annual convention, Belmont Plaza Hotel, New York, N. Y.

October 16–19

Second International Congress on Vacuum Technology, sponsored by International Organization for Vacuum Science and Technology and the American Vacuum Society, Sheraton Park Hotel, Washington, D. C.

OCTOBER 19–20

NCIH, 17th annual national Conference on Industrial Hydraulics, Sherman Hotel, Chicago, Ill.

October 19–21

NSPE, fall meeting, Hotel Roanoke, Roanoke, Va.

October 20–21

Conference on Telluric and Geomagnetic Field Variations, cosponsored by URSI, The University of Texas, and the Office of Naval Research, The University of Texas Student Union Building, Austin, Texas.

October 23–25

URSI-IRE, fall meeting, University of Texas Student Union Building, Austin, Texas.

October 23–26

NACE, conference and exhibition of south central region, Shamrock Hilton Hotel, Houston, Texas.

October 23–27

ASM, 1961 Detroit Metal Show, with participation by 10 American technical societies and trade associations, Cobo Hall, Detroit, Mich.

October 24–26

International Symposium on Aerospace Nuclear Propulsion, sponsored by AEC, NASA, and IRE, Riviera Hotel, Las Vegas, Nev.

October 29–November 1

NLGI, 29th annual meeting, Rice Hotel Houston, Texas.

October 30–November 3

Eighth Institute on Electronics in Management, sponsored by the School of government and public administration, The American University, Washington, D. C.

November 1–3

Industrial Management Society, 25th annual anniversary industrial engineering and management clinic, Pick-Congress Hotel, Chicago, Ill.

November 1–3

SESA, First International Congress on Experimental Mechanics, Hotel New Yorker, New York, N. Y.

November 2–3

Tenth Annual Instrumentation Conference, sponsored by the Louisiana Polytechnic Institute School of Engineering, Ruston, La.

November 6–9

AtomFair-61, sponsored by the American Nuclear Society and Atomic Industrial Forum, Conrad Hilton Hotel, Chicago, Ill.

November 7–9

Seventh Conference on Radio Interference Reduction and Electronic Compatibility, conducted by the Armour Research Foundation, in co-operation with IRE, Illinois Institute of Technology, Chicago, Ill.

November 8–10

First joint national meeting of the Operations Research Society of America and The Institute of Management Sciences, Jack Tar Hotel, San Francisco, Calif.

• IN EUROPE

November 13–16

National Maintenance Conference and Exhibition, organized by *Plant and Factory Maintenance*, to be held at The Central Hall, Westminster, London, England.

November 16–25

Hungarian Scientific Society for Mechanical Engineering, International festival of scientific and technical films for mechanical engineering, Budapest, Hungary.

• IN CANADA

October 19–November 7

The Iron and Steel Institute, special meeting in the U. S. and Canada.

• IN JAPAN

November 6–11

Society of Chemical Engineers, Japan, 25th anniversary congress exhibition, Sankei Hall, Tokyo, Japan.

(For ASME Coming Events, see page 128.)

Notes on
Society Activities
and Events

E. S. NEWMAN
News Editor

THE ASME NEWS

View of United Engineering Center highlights ASME headquarters just before the big move on September 2. The motorized scaffolds, on tracks, are suspended from moveable carriages on the roof. Window cleaners use them in readying UEC for occupancy by enthusiastic tenants.

ASME HQ: UEC*

***TRANSLATION: The Headquarters of The American Society of Mechanical Engineers, as of September 5, 1961, is located in the United Engineering Center, 345 East 47th Street, New York 17, N. Y.**

ASME, after years of planning, is finally in its new headquarters. Over the Labor Day weekend, 40 van-loads of files, furniture, and equipment made the one-mile trip from the West Side to the East Side of Manhattan. The move required 750 cartons to transport everything from a grandfather clock to paperclips; to say nothing about a dozen office machine bins, typewriters, adding machines, calculators, and 137 desks. It took 56 men 13 hours to complete the job.

The 55-year old Engineering Societies Building on 39th Street stands empty—of everything but memories—and the sparkling new United Engineering Center is occupied at last.

Probably the most ambitious undertaking ever attempted by a comparable group of organizations—ASME plus 18 other professional engineering societies—the Center is a monument to the courage and confidence of the engineering profession. For engineers it will stand as a point of pride for years to come. To the American public it will remain a symbol of the vitality and purpose of a dedicated professional group.

To the men of the Council, here is a nostalgic note—the old Council table, now replaced by new furniture at the UEC, was purchased by the Council for Industrial Progress in Management. Too large to fit into an elevator, the table had to be carried by hand down ten flights of stairs.

With less space in the new Center in which to display mementoes accumulated over the years, many were packed for safe storage and periodic display. Others have been loaned to museums or other repositories. Items that will remain on display include Robert Fulton's self-portrait, appraised at some $20,000.

ASME's three meeting rooms on the 7th floor in the Center are named in honor of the Society's three founders: Alexander Lyman Holley, John Edson Sweet, and Henry Rossiter Worthington. Original oil portraits of each hang in the respective rooms.

Andrew Carnegie wasted nothing, much less words. In 1904 when he acquiesced in a proposal of major national professional engineering organizations that he support their hope of a common headquarters and a unified free public engineering library, he wrote as follows: "It will give me great pleasure to devote, say, one and a half million dollars for the erection of a suitable home for you all in New York."

Thus it was that the 16-story Engineering Societies Building at 25–33 West 39th Street came about, now outgrown and outmoded, and succeeded by the United Engineering Center at United Nations Plaza.

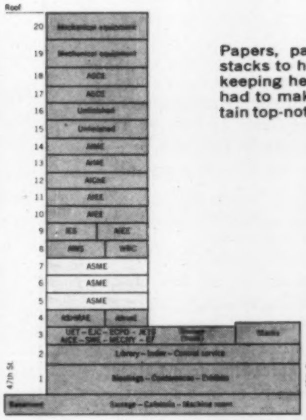


Chart shows ASME location in UEC. The Society occupies 5th, 6th, and 7th floors. See box on next page giving location in UEC of other societies.

Papers, papers everywhere and new stacks to hold them. Efficient housekeeping here was the envy of all who had to make more adjustments to attain top-notch productivity.

Gleaming new file cabinets were moved in early. Some old equipment will be replaced by these units. Other old metal files have been repainted and cleaned up to replace wooden units used for dead storage since 1920.

UEC in Operation

The unified home, originally occupied by three Founder Societies, is now in the new headquarters. There are 19 societies in residence and there is room for more if and when others join the Free World's greatest assembly of engineering organizations.

The Laird of Skibo would be particularly proud of the Engineering Societies Library. It has grown to be what is believed the largest of its kind in the Free World. It provides, in its field, the most comprehensive scope of services. Andrew Carnegie believed intensely that books were the assured means to education of the great numbers of people. His munificence in spreading free public libraries throughout the United States was testimony to his ardor, and his enthusiasm was reflected in his financial sponsorship of the engineering project urged upon him several decades ago.

In time, the 39th Street Building became inadequate. In the space age it had too little space. The Founder Societies and their United Engineering Trustees agency decided on a new headquarters.

Outstanding engineers, industrialists, scientists, educators, and other leaders joined in a massive and exciting campaign which made possible the greater part of the more than $12-million cost of the new 20-story United Engineering Center. The major portion of this sum was contributed by thousands of members of the Founder and other Societies, by industry, and by many others, worldwide, who recognized the importance of the project.

Herbert Hoover's deep interest in the new Center has been demonstrated frequently. The former President of the United States officiated at the ground-breaking ceremony on October 1, 1959, and at the cornerstone laying on June 16, 1960. He is also Honorary Chairman of the dedication ceremonies scheduled for November.

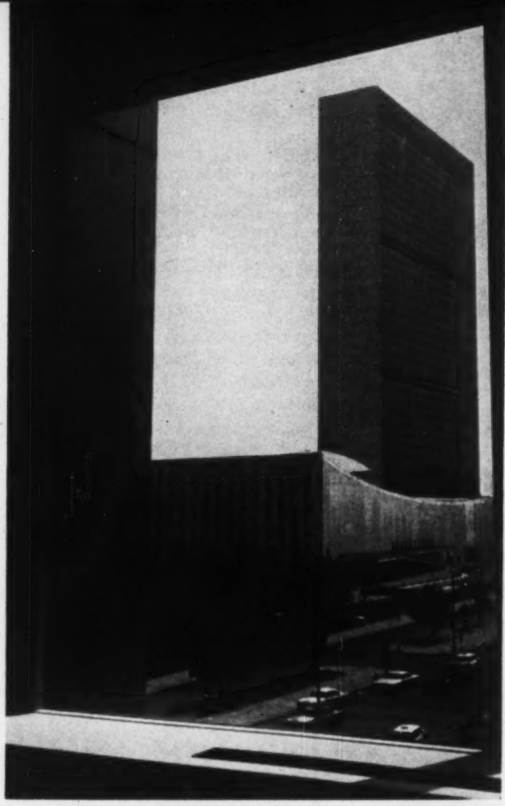
Across 47th Street from the UEC is the Carnegie Endowment for International Peace. It is a significant coincidence, symbolizing in two fields of civilization the idealistic hopes of Andrew Carnegie and his realism in helping make their realization possible.

UEC will be in constant use for meetings of various sizes, and accommodations have been designed accordingly. A main auditorium seating 434 persons is partitionable into three rooms if necessary. There are full facilities for film and lecture presentations, with dimmers for screen purposes. Other meeting areas are provided, with luncheon and dinner accommodations when meetings are held at meal periods.

The Engineering Societies Library is located on the second floor. (See MECHANICAL ENGINEERING, September, 1961, pp. 52–54.) Also on the second floor, building occupants may have the use of central services for duplicating, addressing, mailing, and the like.

An employees' cafeteria of 200 seats is located on the ground floor looking out upon the sunken, landscaped court. Meeting-dining rooms include one for 135 persons and two small ones for 20 each.

ASME occupies the 5th, 6th, and 7th floors. The main reception desk, the Council Room, and the Secretary's office are located on the 6th floor.



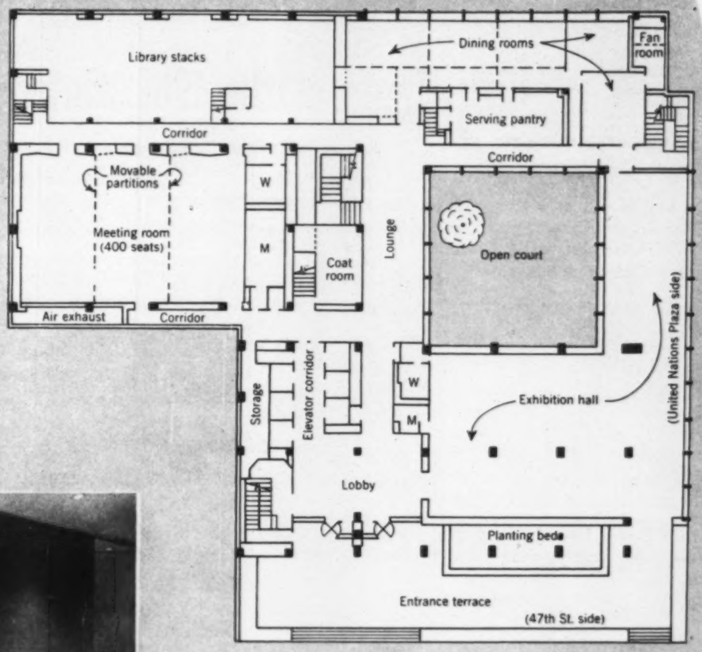
From ASME's seventh floor the view is dominated by United Nations General Assembly building, **foreground**, and Secretariat building, **tower**. United Nations Plaza is in foreground.

Groups That Will Occupy The United Engineering Center

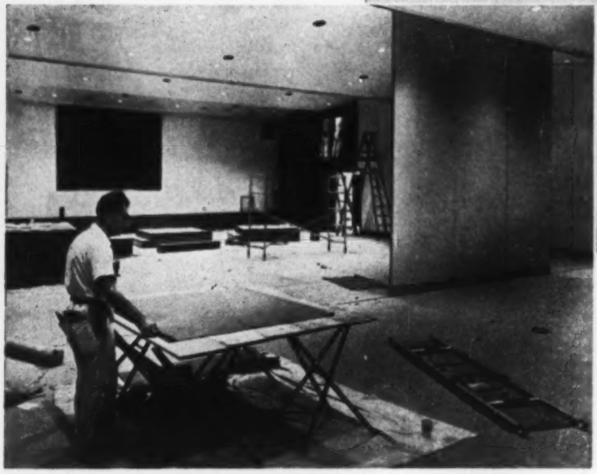
Group Designation	Full Name	Year Founded	Membership mid-1961	Building Floor	N. Y. Staff
ASCE	American Society of Civil Engineers	1852	48,000	17, 18	87
AIME	American Institute of Mining, Metallurgical and Petroleum Engineers	1871	37,150	13, 14	55[1]
ASME	American Society of Mechanical Engineers	1880	49,500	5, 6, 7	140
AIEE	American Institute of Electrical Engineers	1884	55,000	10, 11	95
AIChE	American Institute of Chemical Engineers	1908	22,000	12	45
	The above are known as the Founder Societies				
ASHRAE	American Society of Heating, Refrigerating and Air-Conditioning Engineers	1894	17,800	4	40
MECNY	Municipal Engineers of the City of New York	1903	660	3	1
IES	Illuminating Engineers Society	1906	9,900	9	22
AICE	American Institute of Consulting Engineers	1910	275	3	2
AWS	American Welding Society	1919	12,800	8	38
WRC	Welding Research Council	1935	—	8	7
AIIndE	American Institute of Industrial Engineers	1948	9,700	4	7
SWE	Society of Women Engineers	1950	470	3	1
JETS	Junior Engineering Technical Society	1950	—	13	5
EIS	Engineering Index Service	1884	—	2	30[2]
UET	United Engineering Trustees	1904	—	3	8
ESL	Engineering Societies Library	1913	—	2	25[2]
EF	Engineering Foundation	1914	—	3	2
ECPD	Engineers' Council for Professional Development	1932	10 groups	3	3
EJC	Engineers Joint Council	1945	11 groups	3	15

[1] AIME has 13 at its Society of Petroleum Engineers Office in Dallas, Texas.

[2] These have additional part-time employees.


Library stacks
Dining rooms
Fan room
Serving pantry
Corridor
Corridor
Movable partitions
Meeting room (400 seats)
W
M
Lounge
Coat room
Open court
Air exhaust
Corridor
Storage
Elevator corridor
W
M
Exhibition hall
(United Nations Plaza side)
Lobby
Planting beds
Entrance terrace
(47th St. side)

Floor plan shows some of UEC's outstanding features. Of particular interest: The Exhibition Hall, meeting room, and dining rooms. The open court overlooks a charming garden. The lobby is an impressive gateway to the Center.



Meeting room on the first floor is one of the last to be decorated. The finished room will have a capacity of 450 and can be divided into three smaller rooms. Acoustical planning makes it one of the finest facilities of its kind.

One of the last-minute chores before final occupancy is balancing the air conditioning. Two employees of subcontractor use hooded probe and meter to check flow and temperature of air from overhead duct in a lounge area near the cafeteria.

In the Engineering Societies Library Reading Room workmen put finishing touches on shelves and walls before the deluge of books began August 15. It took ten days to move the 150 van-loads of books. The library has a capacity of 250,000 volumes.

High Lights of the 1961 Winter Annual Meeting

▶SUNDAY, NOVEMBER 26

4:00 p.m. "Early-Bird" Reception

7:00 p.m. Joint Conference of Council, Boards, and Committees

The meeting will be devoted to a discussion of membership.

▶MONDAY, NOVEMBER 27

12:15 p.m. President's Luncheon

Presentation of:

Holley Medal to *Thomas Elmer Moon*

Worcester Reed Warner Medal to *C. L. Willibald Trinks*

Melville Medal to *Otto Erich Baljé*

Address: *William H. Byrne*, ASME President

1:30 p.m. Trip to Republic Aviation Corporation Space Laboratory, Farmingdale, L. I.

4:45 p.m. Business Meeting

Call to Order by the President

High Lights of Interim Reports of the Council, Boards, and Committees

Approval of Constitutional Amendment

Report of Tellers of Election of Officers for 1962–1963

Introduction of Newly Elected Members of the Council

New Business

Adjournment

Members are urged to attend and present their views on Society policy and operation.

8:00 p.m. Social Get-together

▶TUESDAY, NOVEMBER 28

9:00 a.m. Trip to Branson Instruments, Inc., and Barnes Engineering Company, Stamford, Conn.

12:15 p.m. Fuels Luncheon

Speaker: *Jess H. Davis*, president, Stevens Institute of Technology, Hoboken, N. J.

12:15 p.m. Management Luncheon and Towne Lecture

Lecturer: *Walter Scott*, North Sydney, Australia

12:15 p.m. Process Industries—ASHRAE Luncheon

Presentation of scroll commemorating 50th anniversary of Dr. Willis H. Carrier's publication of "Rational Psychrometric Formulae" by *John Everetts, Jr.*, ASHRAE president, and *William H. Byrne*, ASME President

Speaker: *Cloud Wampler*, chairman of the board and chief executive officer, Carrier Corporation, Syracuse, N. Y.

Subject: **The Legacy of Willis Carrier**

1:30 p.m. Trip to Long Island Lighting Company, Glenwood Landing Plant

4:00 p.m. Tea Dance

6:00 p.m. Applied Mechanics Dinner

Presentation of:

Timoshenko Medal to *James Norman Goodier*

6:30 p.m. Hydraulic Dinner

Speaker: *Ray S. Quick*, retired, formerly consulting engineer, Baldwin-Lima-Hamilton Corporation, Philadelphia, Pa.

Subject: **Origin and Objectives of the Hydraulic Division**

▶WEDNESDAY, NOVEMBER 29

12:15 p.m. Heat Transfer Luncheon

Presentation of:

Max Jakob Medal and Award to *Ernst Rudolf Georg Eckert*

Speaker: *James D. Cobine*, physicist, General Electric Research Laboratory, Schenectady, N. Y.

Subject: **Plasma—Surface Effects**

12:15 p.m. Metals Engineering Luncheon

Speaker: *C. S. Smith*, institute professor, Massachusetts Institute of Technology, Cambridge, Mass.

Subject: **The Interaction of the Engineer and the Metallurgist in History**

12:15 p.m. Underwater Technology—ARS Luncheon

Speaker: *Harvey Brooks*, dean of engineering and applied physics; professor of physics, Harvard University, Cambridge, Mass.

1:30 p.m. Trip to Anheuser Busch, Inc., Newark (N. J.) Brewery

6:00 p.m. Social Hour

7:00 p.m. Banquet

Invocation: *Carl J. Eckhardt*, Fellow ASME

Conferral of Honorary Membership on:

Sanford L. Cluett and *Willis F. Thompson*

Presentation of:

Guggenheim Medal to *Jerome F. Lederer*

Speaker: *Kenneth McFarland*, educational consultant and lecturer, General Motors; educational director, American Trucking Associations, Inc.

Subject: **Living to the Point**

10:00 p. m. Dance

▶THURSDAY, NOVEMBER 30

9:00 a.m. Trip to Esso Standard Oil Company Research and Engineering Center, Florham Park, N. J.

12:15 p.m. Members and Students Luncheon

Presentation of:

Junior Award to *Joseph Edward Fleckenstein*

Arthur L. Williston Medal and Award to *James Robert Stewart*

Pi Tau Sigma Richards Memorial Award to *Harrison Allen Storms, Jr.*

Pi Tau Sigma Gold Medal Award to *Ernest Theodore Selig*

Undergraduate Student Award to *Joseph J. Marino*

Charles T. Main Award to *Lester W. Wurm*

Old Guard Prize Paper: **Considerations for the Design of an Ammonia-Phosphoric Acid Reactor,** by *Joseph J. Marino*, University of Connecticut, Storrs, Conn.

COLLEGE REUNIONS

Additional information about time and place may be obtained at ASME Registration Headquarters at the Statler Hilton Hotel during the meeting.

Brown University will have a reunion on Thursday, Nov. 30, 1961.

The Cooper Union Alumni are cordially invited to attend a Mechanical Engineering Department reunion at The Cooper Union on Thursday evening, Nov. 30, 1961, in Room 252 of the New Engineering Building on Astor Place. The Department Laboratories will be open from 5:30 to 6:30 p.m., and staff members will be present to greet our guests. A dinner is planned on a personal basis at some nearby restaurant. All who are planning to attend are urged to call Prof. W. A. Vopat as early in the week as possible at ALgonquin 4-6300.

Cornell University: There will be a reunion for the Cornell Society of Engineers. All Cornellians and their male guests are cordially invited to attend. Time: Cocktails at 5:30 p.m., dinner at 6:30 p.m. Date: Nov. 30, 1961, at The Engineers Club, 32 West 40th Street. (Guest speaker after dinner.) Contact: R. J. Broeker, The Columbia Gas System, Inc., 120 East 41st Street, New York 17, N. Y. ORegon 9-4500.

The Ohio State University: All Ohio State engineers are invited to a College Reunion in New York City on Thursday, November 30. Ladies are welcome. The reunion will be held at the White Turkey Restaurant, 38th Street at Madison Avenue. Time: 6:00 p.m. Price $5.50 per plate. For reservations contact: Henry Abbott, Bell Telephone Laboratories, 463 West Street, New York, N. Y. Phone: CH 3-1000, or Associate Dean Marion L. Smith, College of Engineering, The Ohio State University, Columbus 10, Ohio.

Pratt Institute Reunion Dinner will be held at Keen's English Chop House on Nov. 30, 1961, at 6:00 p.m. For reservations and further information contact Prof. Kenneth E. Quier, Pratt Institute, MAin 2-2200.

Purdue University: A reunion will be held on Wednesday, Nov. 29, 1961. Contact Prof. D. S. Clark, School of Mechanical Engineering, Purdue University, Lafayette, Ind.

Rensselaer Polytechnic Institute will have a college reunion luncheon at 12:00 noon on Thursday, Nov. 30, 1961, at the Engineers Club. 32 West 40th Street, New York, N. Y. Contact: C. E. Davies, RPI Alumni Association, 10 East 43rd Street, New York, N. Y. MUrray Hill 2-5350.

Stevens Institute of Technology Reunion luncheon will be held at the Stevens Metropolitan Club on Thursday, November 30. Cocktails at 12:00 noon and Luncheon at 12:30 p.m. Contact: Myles Williamson, % C. H. Wheeler Manufacturing Co., 285 Madison Avenue, New York 17, N. Y. or call CIrcle 7-7431.

Registration Schedule

Sunday, November 26, 2:00 p.m. to 6:00 p.m.
Monday, November 27, 8:00 a.m. to 8:00 p.m.
Tuesday, November 28, 8:00 a.m. to 8:00 p.m.
Wednesday, November 29, 8:00 a.m. to 3:00 p.m.
Thursday, November 30, 8:00 a.m. to 12 noon

Tufts College will have a reunion luncheon on Thursday, Nov. 30, 1961, at the Zeta Psi Club, 31 East 39th Street, New York, N. Y. Contact: Frederick J. Flynn, 224 Eleventh Street, Garden City, N. Y. PIoneer 7-0012.

The *University of Missouri* will have a College Reunion dinner on November 30 at the Governor Clinton Hotel at 6:30 p.m. Contact Miss M. Gilfillan (Secretary to J. J. Begley), Kudner Agency, Inc., 575 Madison Avenue, New York, N. Y. Phone: MUrray Hill 8-6700.

PLANT TRIPS

▶MONDAY, NOVEMBER 27

1:30 p.m.	Republic Aviation Corporation Space Laboratory, Farmingdale, L. I.

▶TUESDAY, NOVEMBER 28

9:00 a.m.	Branson Instruments, Incorporated, and Barnes Engineering Company, Stamford, Conn.
1:30 p.m.	Long Island Lighting Company, Glenwood Landing Plant

▶WEDNESDAY, NOVEMBER 29

1:30 p.m.	Anheuser Busch Incorporated, Newark Brewery

▶THURSDAY, NOVEMBER 30

9:00 a.m.	Esso Standard Oil Company Research and Engineering Center, Florham Park, N. J.

AIR POLLUTION CONTROLS SESSION

MONDAY, NOVEMBER 27 9:30 a.m.

Jointly With Safety and Human Factors

See Safety 1

APPLIED MECHANICS SESSIONS

1 MONDAY, NOVEMBER 27 9:30 a.m.

Thermodynamics—Diffraction Problems

A Single Axiom for Classical Thermodynamics, by *G. N. Hatsopoulos* and *J. H. Keenan*, M.I.T. (Paper No. 61—WA-110)

The Influence of Molecular Vibration on Brayton Cycle Performance, by *T. A. Jacobs*, Aerospace Corp., and *J. R. Lloyd*, California Inst. of Tech. (Paper No. 61—WA-51)

The Second Fundamental Problem in Heat Transfer of Laminar Forced Convection, by *L. N. Tao*, Illinois Inst. of Tech. (Paper No. 61—WA-108)

Displacements and Velocities Produced by the Diffraction of a Pressure Wave by a Cylindrical Cavity in an Elastic Medium, by *M. L. Baron*, Paul Weidlinger, Consulting Engineer, and Professor, Columbia Univ.; and *Raymond Parnes*, Paul Weidlinger, Consulting Engineer (Paper No. 61—WA-60)

Diffraction of Pulses by Cylindrical Obstacles of Arbitrary Cross Section, by *M. B. Friedman*, Columbia Univ., and *R. Shaw*, Pratt Inst. (Paper No. 61—WA-55)

Thermal Results for Forced Heat Convection Through Elliptical Ducts,[1] by *N. T. Dunwoody*, The Queen's University of Belfast, Belfast, Northern Ireland (Paper No. 61—WA-40)

Irreversible Thermodynamics of the Thermal Characteristics of Porous Insulators,[1] by *R. G. Mokadam*, Indian Inst. of Tech., Kharagpur, India (Paper No. 61—WA-9)

2 MONDAY, NOVEMBER 27 2:30 p.m.

Plasticity and Viscoelasticity

Interaction Curves for Circular Cylindrical Shells According to the Mises or Tresca Yield Criterion, by *P. G. Hodge, Jr.*, and *Joseph Panarelli*, Illinois Inst. of Tech. (Paper No. 61—WA-103)

On Thermally Stressed Elastic-Plastic Shells, by *E. T. Onat* and *S. Yamanturk*, Brown Univ. (Paper No. 61—WA-62)

On the Meaning of Isoclinic Parameters in the Plastic State in Cellulose Nitrate, by *M. M. Frocht*, Illinois Inst. of Tech., and *Y. F. Cheng*, Boeing Scientific Res. Labs. (Paper No. 61—WA-148)

A General Solution for the Elastoplastic Thermal Stresses in a Strain-Hardening Plate With Arbitrary Material Properties, by *Alexander Mendelson* and *S. W. Spero*, NASA, Lewis Res. Center (Paper No. 61—WA-151)

Application of Moire Methods to the Determination of Transient Stress and Strain Distributions, by *W. F. Riley*, Illinois Inst. of Tech., Armour Res. Foundation, and *A. J. Durelli*, Catholic Univ. of America (Paper No. 61—WA-10)

A Problem in Viscoelasticity,[1] by *E. J. Appleby* and *W. Prager*, Brown Univ. (Paper No. 61—WA-59)

The Rolling Contact of a Rigid Cylinder With a Viscoelastic Half Space,[1] by *S. C. Hunter*, A.R.D.E., Fort Halstead, Sevenoaks, Kent, England (Paper No. 61—WA-8)

A Plane Problem of Rolling Contact in Linear Viscoelasticity Theory,[1] by *L. W. Morland*, Univ. of Manchester, England (Paper No. 61—WA-49)

Similitude in Package Cushioning,[1] by *W. G. Soper*, U. S. Naval Weapons Lab., and *R. C. Dove*, Univ. of New Mexico (Paper No. 61—WA-50)

3 MONDAY, NOVEMBER 27 8:00 p.m.

Shock and Vibration

Displacement and Strain-Energy Distribution in a Longitudinally Vibrating Cylindrical Rod With a Viscoelastic Coating, by *P. Hertelendy*, Nat. Bur. of Stds. (Paper No. 61—WA-30)

Transient Compressional Waves in an Infinite Elastic Plate or Elastic Layer Overlying a Rigid Half-Space, by *Julius Miklowitz*, California Inst. of Tech. (Paper No. 61—WA-21)

Transient Analysis of Shear Impact, by *Andrew Pytel* and *Norman Davids*, Pennsylvania State Univ. (Paper No. 61—WA-15)

Random Vibration of Beams, by *S. H. Crandall* and *Asim Yildiz*, M.I.T. (Paper No. 61—WA-149)

Torsional Vibrations of Shells of Revolution, by *H. R. Garnet*, *M. A. Goldberg*, and *V. L. Salerno*, Grumman Aircraft Engrg. Corp. (Paper No. 61—WA-6)

Energy Dissipation in Contact Friction: Constant Normal and Cyclic Tangential Loading, by *L. E. Goodman* and *C. B. Brown*, Univ. of Minnesota (Paper No. 61—WA-29)

On a Restricted Class of Coupled Hill's Equations and Some Applications,[1] by *C. S. Hsu*, Univ. of California (Paper No. 61—WA-7)

Physical Interpretation of Fictitious Nodes Encountered in the Node Method of Vibrations,[1] by *G. C. Best*, Fort Worth, Texas (Paper No. 61—WA-4)

On Vibration of Elastic Spherical Shells,[1] by *P. M. Naghdi*, Univ. of California, and *Arturs Kalnins*, Yale Univ. (Paper No. 61—WA-42)

Dispersion of Flexural Waves in an Elastic, Circular Cylinder—Part 2,[1] by *Yih-Hsing Pao*, Cornell Univ. (Paper No. 61—WA-43)

4 TUESDAY, NOVEMBER 28 9:30 a.m.

Symposium: Magnetohydrodynamics

Concepts of Magnetohydrodynamics,[2] by *Julian Cole*, California Inst. of Tech.

Nonlinear Theory of Wave Propagation in Plasmas,[2] by *P. A. Sturrock*, Stanford Univ.

MHD Channel Flow of Combustion Product Gas in Dissociation Equilibrium,[2] by *Stewart Way*, Westinghouse Res. Labs.

5 TUESDAY, NOVEMBER 28 2:30 p.m.

Instability

Dynamic Creep Instability of Initially Straight, Centrally Loaded Columns, by *W. E. Jahsman* and *F. A. Field*, Lockheed Aircraft Corp. (Paper No. 61—WA-101)

Torsional Creep Buckling of Open Tubes Having Arbitrary Cross Section, by *George Lianis*, Purdue Univ. (Paper No. 61—WA-14)

Strongest Columns and Isoperimetric Inequalities for Eigenvalues, by *Iradj Tadjbakhsh*, Rensselaer Polytechnic Inst., and *J. B. Keller*, New York Univ. (Paper No. 61—WA-20)

Buckling of an Axially Compressed Long Cylindrical Shell With an Elastic Core, by *J. C. Yao*, Aerospace Corp. (Paper No. 61—WA-102)

Stability of Two Planar Loop Elasticas, by *E. E. Zajac*, Bell Telephone Labs., Inc. (Paper No. 61—WA-11)

The Buckling of Cylindrical Shells Under Longitudinally Varying Loads, by *Victor Weingarten*, Space Technology Labs., Inc. (Paper No. 61—WA-153)

6 WEDNESDAY, NOVEMBER 29 9:30 a.m.

Jointly With Petroleum

Elastic Plates and Shells

On Surface Constraints in Plate Problems, by *F. Essenburg*, Illinois Inst. of Tech. (Paper No. 61—WA-105)

Application of Reissner's Variational Principle to Cantilever Plate Deflection and Vibration Problems, by *H. J. Plass, Jr.*, and *J. H. Gaines*, Univ. of Texas, and *C. D. Newsom*, Boeing Airplane Co. (Paper No. 61—WA-61)

Design of Perforated Plates, by *W. J. O'Donnell* and *B. F. Langer*, Westinghouse Elec. Corp. (Paper No. 61—WA-115)

Influence Coefficients for Thin Smooth Shells of Revolution Subjected to Symmetric Loads, by *B. R. Baker* and *G. B. Cline, Jr.*, Lockheed Missiles & Space Div. (Paper No. 61—WA-106)

Analysis of U-Shaped Expansion Joints, by *A. Laupa*, RAND Corp., and *N. A. Weil*, Armour Res. Foundation (Paper No. 61—WA-41)

Stresses in Tapered Transition Joints in Pipelines and Pressure Vessels, by *E. C. Rodabaugh*, Chemetron Corp., and *T. J. Atterbury*, Battelle Memorial Inst. (Paper No. 61—WA-117)

The Axially Loaded Circular Cylinder,[1] by *H. D. Conway*, Cornell Univ. (Paper No. 61—WA-24)

Further Consideration of the Thick-Plate Problem With Axially Symmetric Loading,[1] by *C. W. Nelson*, IBM Corp. (Paper No. 61—WA-54)

7 WEDNESDAY, NOVEMBER 29 2:30 p.m.

Shock and Vibrations—Elasticity

Random Vibration of a Nonlinear System With a Set-up Spring, by *S. H. Crandall*, M.I.T. (Paper No. 61—WA-152)

Shock Response of a Nonlinear System, by *Y. C. Fung*, California Inst. of Tech., and Space Technology Labs., Inc.; and *M. V. Barton*, Space Technology Labs., Inc. (Paper No. 61—WA-107)

The Normal Modes of Nonlinear n-Degree-of-Freedom Systems, by *R. M. Rosenberg*, Univ. of California (Paper No. 61—WA-22)

The Elastic Plane With a Circular Insert, Loaded by a Tangentially Directed Force, by *M. Hetényi* and *J. Dundurs*, Northwestern Univ. (Paper No. 61—WA-150)

The Elastic Moduli of Heterogeneous Materials by *Zvi Hashin*, Univ. of Pennsylvania (Paper' No. 61—WA-39)

Bending Deflection of a Circular Shaft Terminating in a Semi-Infinite Body,[1] by *J. M. Brown*, Aerospace Corp. and *A. S. Hall, Jr.*, Purdue Univ. (Paper No. 61—WA-146)

Flexural Wave Propagation and Vibration of Laminated Rods and Beams,[1] by *Hideo Saito* and *Kiichi Sato*, Tohoku Univ., Sendai, Japan (Paper No. 61—WA-58)

On Vibrations of Pretwisted Plates,[1] by *R. P. Nordgren*, Univ. of California (Paper No. 61—WA-23)

8 THURSDAY, NOVEMBER 30 9:30 a.m.

Hydrodynamics

Slow Viscous Flow Between Rotating Concentric Infinite Cylinders With Axial Roughness, by *S. J. Citron*, Purdue Univ. (Paper No. 61—WA-5)

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[1] Not presented orally.

[2] Not to be printed.

Orders for ASME Technical Papers

Only numbered ASME papers in this program are available in separate copy form until Oct. 1, 1962. Prices are 50 cents to members of ASME, $1 to nonmembers, plus postage and handling charges. Payment also may be made by free coupons, or coupons which may be purchased from the Society in lots of ten at $4 to members; $8 to nonmembers.

You can save the postage and handling charges by including your check or money order made payable to ASME with your order and sending both to: ASME Order Department, United Engineering Center, 345 East 47th Street, New York 17, N.Y. Papers must be ordered by the paper numbers listed in this program, otherwise the order will be returned. The issue of Mechanical Engineering containing an account of the Winter Annual Meeting also will carry a complete listing of all available papers.

Note: All numbered papers in this program will be available two weeks before the opening date of the meeting. Hence some mail orders may be delayed for this reason.

Effects of a Magnetic Field on Natural Convection in a Toroidal Channel, by *Paul Concus,* Univ. of California (Paper No. 61—WA-53)

Asymptotic Solutions for Unsteady Laminar Free Convection on a Vertical Plate, by *E. R. Menold,* Case Inst. of Tech., and *Kwang-Tzu Yang,* Univ. of Notre Dame (Paper No. 61—WA-109)

Fluid Flow Between Porous Rollers, by *L. N. Tao* and *D. D. Joseph,* Illinois Inst. of Tech. (Paper No. 61—WA-104)

An Approximate Analysis of Laminar Magnetohydrodynamic Flow in the Entrance Region of a Flat Duct, by *Michael Roidt,* Westinghouse Res. Labs., and *R. D. Cess,* State Univ. of New York (Paper No. 61—WA-147)

Non-Newtonian Flow in Annuli,[1] by *Zeev Rotem,* Israel Inst. of Tech., Haifa, Israel (Paper No. 61—WA-57)

Some Measurements of a Wake-Boundary Layer Interaction,[1] by *Roger Eichhorn,* Princeton Univ., and *T. L. Eddy,* Univ. of Minnesota (Paper No. 61—WA-52)

A Two-Phase Boundary Layer and Its Drag Reduction Characteristics,[1] by *E. M. Sparrow, V. K. Jonsson,* and *E. R. G. Eckert,* Univ. of Minnesota (Paper No. 61—WA-56)

Magnetohydrodynamic Flow and Heat Transfer About a Rotating Disk,[1] by *E. M. Sparrow,* Univ. of Minnesota, and *R. D. Cess,* State Univ. of New York (Paper No. 61—WA-111)

9 THURSDAY, NOVEMBER 30 2:30 p.m.
Jointly With Metals Engineering
Colloquium: Engineering Implications of the Physics of Solids

Survey,[2] by *E. Orowan,* M.I.T.

The Structure of Matter,[2] by *M. J. Sinnott,* Univ. of Michigan

Technological Consequences of Dislocation Physics,[2] by *J. J. Gilman,* Brown Univ.

Physical Concepts Versus Engineering Interpretations of Flow and Fracture,[2] by *E. R. Parker,* Univ. of California

Nonmechanical Properties,[2] by *J. Goldman,* Ford Motor Co.

AMERICAN ROCKET SOCIETY SESSION

WEDNESDAY, NOVEMBER 29 2:30 p.m.
Jointly With Underwater Technology
See Underwater Technology 2

AMERICAN SOCIETY OF HEATING, REFRIGERATING AND AIR-CONDITIONING ENGINEERS, INC. SESSIONS

TUESDAY, NOVEMBER 28 9:30 a.m.
Jointly With Process Industries
See Process Industries 1

TUESDAY, NOVEMBER 28 2:30 p.m.
Jointly With Process Industries
See Process Industries 2

WEDNESDAY, NOVEMBER 29 9:30 a.m.
Jointly With Process Industries
See Process Industries 3

AUTOMATIC CONTROL SESSIONS

1 MONDAY, NOVEMBER 27 9:30 a.m.
Panel Discussion: Uncertainties Affecting Mechanical Design of Instruments and Control Systems

Friction and Wear,[2] by *Ernest Rabinowicz,* M.I.T.

The Dimensional Stability of Materials and Its Importance in Instrument Performance,[2] by *L. M. Schetky,* The Alloyd Corp.

Properties of Flexural Members,[2] by *N. H. Cook,* M.I.T.

The Uncertainties in Electrical Contacts,[2] by *R. H. Koester,* Electro-Tec Corp.

2 MONDAY, NOVEMBER 27 2:30 p.m.

The Optimum Response of Full Third Order Systems With Contactor Control,[1] by *Irmgard Flügge-Lotz* and *H. A. Titus,* Stanford Univ. (Paper No. 61—WA-125)

Effect of Sinusoidal Inputs to Nonlinear Systems, by *Rufus Oldenburger* and *R. C. Boyer,* Purdue Univ. (Paper No. 61—WA-66)

A Contribution to Liapunov's Second Method: Nonlinear Autonomous Systems, by *G. P. Szego,* Purdue Univ. (Paper No. 61—WA-192)

Performance Improvement of Process Controller by a Gain Switching,[2] by *Yasundo Takahashi,* Univ. of California, and *Robert Harris,* Gen. Dynamics/Astronautics

3 MONDAY, NOVEMBER 27 8:00 p.m.

The Transient Response of Fluid Lines, by *F. T. Brown,* M.I.T. (Paper No. 61—WA-143)

Temperature-Frequency Response for Air Flowing in a Brass Pipe,[2] by *F. S. Rossi,* U. S. Quartermaster Res. and Engrg. Command, and *H. Thal-Larsen,* Univ. of California

Electrical Analog Simulation of a Heat-Exchange Pipe Thermocouple-Temperature Sensor,[2] by *V. S. Sohoni* and *J. C. Even, Jr.,* Vapor Heating Corp.

TUESDAY, NOVEMBER 28 9:30 a.m.
Jointly With Fuels and Power
See Fuels 3

AVIATION SESSIONS

MONDAY, NOVEMBER 27 9:30 a.m.
Jointly With Gas Turbine Power
See Gas Turbine Power 1

MONDAY, NOVEMBER 27 2:30 p.m.
Jointly With Gas Turbine Power
See Gas Turbine Power 2

TUESDAY, NOVEMBER 28 9:30 a.m.
Jointly With Gas Turbine Power
See Gas Turbine Power 4

1 WEDNESDAY, NOVEMBER 29 9:30 a.m.
Satellite Tracking and Communications

Requirements for 1960–1970,[2] by *E. W. Wahl,* AFESD

Large Mechanical Systems,[2] by *H. Weiss,* M.I.T

Large Phased Arrays,[2] by *C. S. Lerch,* Bendix Aviation Corp.

Runout Path of an Airplane Equipped With Skids,[1] by *C. Ip,* The Martin Co. (Paper No. 61—WA-1)

2 WEDNESDAY, NOVEMBER 29 2:30 p.m.
Deep Space Probe

Requirements for 1960–1970,[2] by *E. Rechtin*

Major Mechanical Design Problems and Performance Limitations of Present Equipment,[2] by *B. H. Rule,* California Inst. of Tech.

Advanced Antenna System Easibility Study,[2] by *Robertson Steves*

Hydraulic-Drive Design and Development BMEWS Tracking Radar Antenna Pedestal,[1] by *J. Cardinal* (Paper No. 61—WA-81)

BOILER FEEDWATER STUDIES SESSIONS

1 TUESDAY, NOVEMBER 28 9:30 a.m.
Jointly With Power

An Experimental Investigation of Some of the Factors Which Affect the Accuracy of Steam Sampling,[2] by *C. R. Clark* and *Michael Lawlor,* Foster Wheeler Corp.

The Solubility of Copper and Its Oxides in Supercritical Steam, by *F. J. Pocock* and *J. F. Stewart,* The Babcock & Wilcox Co. (Paper No. 61—WA-140)

Water Side Failures in High-Pressure Boilers—A Field Survey,[2] by *Clarence Jacklin,* Nalco Chemical Co.

2 TUESDAY, NOVEMBER 28 2:30 p.m.
Jointly With Power

Chemical Cleaning of High-Pressure Systems Containing Austenitic Stainless Steels,[2] by *J. P. Engle* and *C. F. Reich,* The Dow Chemical Co.

Experiences With Hydrazine in Marine-Steam Generators, by *J. S. Beecher, E. A. Savinelli,* and *J. A. Ulrich, Jr.,* E. F. Drew & Co., Inc. (Paper No. 61—WA-190)

The Influence of Dissolved Oxygen on Pitting of Boiler Tubes,[2] by *E. P. Shea, A. L. Kimmel,* and *W. R. Hollingshad,* Midwest Res. Inst.

CORROSION AND DEPOSITS SESSION

THURSDAY, NOVEMBER 30 9:30 a.m.

Experience With Porcelain-Enamel Coatings in Low-Temperature Flue-Gas Streams, by *L. D. Grames* and *H. Huffcut,* The Air Preheater Corp. (Paper No. 61—WA-137)

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[1] Not presented orally.
[2] Paper not available—see box on this page.

Corrosion and Deposits in Low-Level Economizers, by *G.C. Wiedersum, Jr.*, Philadelphia Elec. Co., *W. E. Brockel* and *J. D. Sensenbaugh*, Combustion Engrg., Inc. (Paper No. 61—WA-138)

Corrosion Problems in Stacks and Ducts, by *D. O. Thompson*, Commonwealth Edison Co. (Paper No. 61—WA-136)

EFFECT OF RADIATION SESSION

TUESDAY, NOVEMBER 28 9:30 a.m.

Environmental Factors Which Influence Materials Properties and Nuclear Reactor Design,[3] by *C. O. Smith*, Oak Ridge Nat. Lab.

Experimental Techniques for Determination of Properties of Materials Exposed to Nuclear Radiation,[3] by *R. G. Berggren*, Oak Ridge Nat. Lab.

Effects of Nuclear Radiation on the Properties of Structural Materials for Reactors Applications,[3] by *L. E. Steele* and *J. R. Hawthorne*, U. S. Naval Res. Lab.

Considerations in the Design of Nuclear Reactor Vessels,[3] by *J. G. Yevick*, Atomic Power Dev. Associates, Inc.

FLUID METERS SESSIONS

1 WEDNESDAY, NOVEMBER 29 2:30 p.m.

Review of Critical Flow Meters for Gas-Flow Measurements, by *B. T. Arnberg*, Univ. of Colorado (Paper No. 61—WA-181)

A Theoretical Method for Determining Discharge Coefficients for Venturis Operating at Critical Flow Conditions,[3] by *R. E. Smith, Jr.*, and *R. J. Mats*, Arnold Engrg. Dev. Center

2 THURSDAY, NOVEMBER 30 9:30 a.m.

Two-Phase Flow Measurement With Orifices, by *J. W. Murdock*, Philadelphia Naval Shipyard (Paper No. 61—WA-27)

Quadrant Edge Orifice Performance: Effect of Upstream Velocity Distribution, by *Marvin Bogema*, Cornell Univ., *Bradford Spring*, Clarkson College of Tech., and *M. V. Ramamoorthy*, Ihiagarajar College of Engrg., Madurai, Madras (Paper No. 61—WA-28)

3 THURSDAY, NOVEMBER 30 2:30 p.m.

Performance Characteristics of Turbine Flowmeters, by *M. R. Shafer*, Nat. Bur. of Standards (Paper No. 61—WA-25)

Design and Calibration of the Lo-Loss Tube, by *L. J. Hooper*, Worcester Polytechnic Inst. (Paper No. 61—WA-80)

The Pulsation Error of Rotameters,[3] by *J. F. Ury*, Israel Inst. of Tech., Haifa, Israel

FUELS SESSIONS

1 MONDAY, NOVEMBER 27 9:30 a.m.

Thawing of Frozen Coal in Railroad Cars

Electric Infrared Railroad-Coal Car Thawing Installation,[3] by *J. J. Bosl*, Cleveland Elec. Illuminating Co.

Thawing Coal in Railway Cars, by *F. B. Manning* and *Emil Szaks*, The Chesapeake & Ohio Ry Co. (Paper No. 61—WA-33)

Coal-Car Thawing With Gas Infrared and Oil-Fired Units, by *T. C. Sparks*, Toledo, Lorain & Fairport Co., and *H. L. Zouck*, The Baltimore & Ohio RR Co. (Paper No. 61—WA-64)

2 MONDAY, NOVEMBER 27 2:30 p.m.

Jointly With Power

Fly Ash Utilization

Factors Relevant to the Conversion of Fly Ash Into a Lightweight Aggregate When Using the Sintering Process,[3] by *C. M. Weinheimer*, The Detroit Edison Co.

The Application of the Roto-Flux Magnetic Separator to Pulverized Coal Fly Ash,[3] by *L. J. Minnick*, G. & W. H. Corson, Inc.

A New Use for Fly Ash as a Lightweight Ceramic Building Material,[3] by *E. C. Bailey*, Commonwealth Edison Co., *J. S. Griffith* and *J. T. Dusek*, Armour Res. Foundation

3 TUESDAY, NOVEMBER 28 9:30 a.m.

Jointly With Power and Automatic Control

Burner Design and Measurement of Combustion Components

Continuous Combustion Indicator Provides for Accurate Combustion Control,[3] by *Thomas Liddell*, Selas Corp. of America

Sampling, Analyzing, and Control of Oxygen in Boiler Flue Gas,[3] by *F. C. Luxl*, Leeds & Northrup Co.

Development of Burners for Industrial and Utility Boilers,[3] by *George Musat* and *J. M. Rackley*, The Babcock & Wilcox Co.

4 TUESDAY, NOVEMBER 28 2:30 p.m.

Jointly With Power

Furnace Safeguards and Flame-Failure Equipment Development

Preventing Boiler-Furnace Explosions: Report of the ASME Fuels Division Subcommittee on Flame Safety Devices and Safe-Operating Practices, by *E. R. Mitchell*, Dept. of Mines & Technical Surveys, Ottawa, Canada (Paper No. 61—WA-197)

Review of Furnace-Protection Design Principles,[3] by *A. W. Hindenlang*, Combustion Publishing Co., Inc., *W. L. Livingston*, Combustion Engrg., Inc., *R. M. Lundberg*, Commonwealth Edison Co., and *K. W. Hamming*, Sargent & Lundy

Combustion Monitoring of Large Flames by Flame Radiation,[3] by *L. F. Gilbert* and *F. A. Baumgartel*, Bailey Meter Co., *W. T. Hage*, The Babcock & Wilcox Co., and *E. R. Mitchell*, Dept. of Mines & Technical Surveys, Ottawa, Canada

WEDNESDAY, NOVEMBER 29 9:30 a.m.

Jointly With Furnace Performance Factors

See Furnace Performance Factors

FURNACE PERFORMANCE FACTORS SESSION

WEDNESDAY, NOVEMBER 29 9:30 a.m.

Jointly With Fuels

The Use of Visible Light Models for the Study of Radiant Heat Transfer in Furnaces,[3] by *A. A. Orning*, *C. H. Schwartz*, and *S. A. Goldberg*, U. S. Bur. of Mines

Flow Modeling of Furnaces and Ducts, by *R. C. Patterson* and *R. F. Abrahamsen*, Combustion Engrg., Inc. (Paper No. 61—WA-45)

A Study of Conditions Needed for Producing Small Stable Pulverized Coal Flames,[3] by *C. R. McCann* and *A. A. Orning*, U. S. Bur. of Mines

GAS TURBINE POWER SESSIONS

1 MONDAY, NOVEMBER 27 9:30 a.m.

Jointly With Aviation

Combustion in European Gas Turbines, by *W. Tipler*, Shell International Petroleum Co. Ltd., London, England (Paper No. 61—WA-82)

A Jet-Engine Combustor Design Analysis Suitable for Electronic Computers,[3] by *B. P. Samuel*, Gen. Elec. Co.

2 MONDAY, NOVEMBER 27 2:30 p.m.

Jointly With Aviation

Spray Distribution and Drop Size From a Swirl Atomizer,[3] by *Mario De Corso*, Westinghouse Res. Labs.

Performance Evaluation of a Gaseous Hydrogen-Liquid Oxygen Gas Generator Designed for Driving Hot-Gas Research Turbines,[3] by *C. L. Ball*, NASA, Lewis Res. Center

3 MONDAY, NOVEMBER 27 8:00 p.m.

Seminar: Gas-Turbine Fuels

4 TUESDAY, NOVEMBER 28 9:30 a.m.

Jointly With Aviation

A Nuclear Reactor for Gas Turbines—Experimental and Operating Data,[3] by *C. M. Rice*, Aerojet-Gen. Corp., and *R. H. Chesworth*, Nat. Reactor Testing Station

Effects of Fuel Properties on Liner Temperatures and Carbon Deposition in the CJ805 Combustor for Long-Life Applications,[3] by *R. A. Macaulay* and *M. W. Shayeson*, Gen. Elec. Co.

5 TUESDAY, NOVEMBER 28 2:30 p.m.

A Study of Axial-Flow Turbine Efficiency Characteristics in Terms of Velocity Diagram Parameters, by *W. L. Stewart*, NASA, Lewis Res. Center (Paper No. 61—WA-37)

A Pneumatic Control System for a Gas Turbine,[3] by *John Dobson*, Foxboro Corp.

6 TUESDAY, NOVEMBER 28 8:00 p.m.

Jointly With Power

Operating Experience of General Electric Gas Turbines Through January 1, 1961,[3] by *H. D. McLean*, Gen. Elec. Co.

Design and Performance of a Compact Conversion Plant,[3] by *G. F. Mader*, Gas-Turbine-Test Facility, Fort Belvoir, Va., *W. Crim*, U. S. AEC, *H. Skinner* and *R. K. Swain*, Aerojet-General Corp.

HEAT TRANSFER SESSIONS

1 MONDAY, NOVEMBER 27 9:30 a.m.

Radiation

Heat Transfer by Combined Forced Convection and Thermal Radiation in a Heated Tube, by *Morris Perlmutter* and *Robert Siegel*, NASA, Lewis Res. Center (Paper No. 61—WA-169)

Rapid Calculation of Radiant Energy Transfer Between Nongray Walls and Isothermal H_2O or CO_2 Gas, by *D. K. Edwards* and *K. E. Nelson*, Univ. of California (Paper No. 61—WA-175)

Thermal Efficiency of Coated Fins, by *J. A. Plamondon*, California Inst. of Tech. (Paper No. 61—WA-168)

An Enclosure Theory for Radiative Exchange Between Specularly and Diffusely Reflecting Surfaces, by *E. M. Sparrow*, *E. R. G. Eckert*, and *V. K. Jonsson*, Univ. of Minnesota (Paper No. 61—WA-167)

Radiant Absorption Characteristics of Concave Cylindrical Surfaces, by *E. M. Sparrow*, Univ. of Minnesota (Paper No. 61—WA-145)

MONDAY, NOVEMBER 27 9:30 a.m.

Jointly With Petroleum and Power

See Petroleum 1

2-A MONDAY, NOVEMBER 27 2:30 p.m.

Symposium: Heat Processing and Control in Industrial Furnaces and Fluidized Beds

Heat Transfer by High-Velocity Air Streams in Industrial Furnaces,[3,4] by *J. Huebler* and *J. C. Scarlett*, Midland-Ross Corp.

Pitfalls in Convection Heating Calculations,[3,4] by *H. M. Short*, Aluminum Co. of America

An Analog Study of the Transient Behavior of a Batch-Type Fluidized Bed for Metallurgical Heat Treating,[3,4] by *C. O. Pedersen*, Gen. Elec. Co.

Various Geometric Representations of the Passive Element Simulator and Their Application to the Melting of Aluminum Pigs,[3,4] by *C. L. Feng*, Selas Corp. of America

The Use of Electronic Contactors in Heat-Process Control Systems,[3,4] by *W. H. Christiansen*, Gen. Elec. Co.

2-B MONDAY, NOVEMBER 27 2:30 p.m.

Heat Conduction

Heat Conduction in the Infinite Region Exterior to a Rectangle, by *K. H. Coats*, Univ. of Michigan (Paper No. 61—WA-180)

The Fusion Times of Slabs and Cylinders, by *D. C. Baxter*, Nat. Res. Council of Canada, Ottawa, Ont., Canada (Paper No. 61—WA-179)

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[3] Paper not available—see box on page 112.

[4] A bound volume consisting of all papers presented at this session will be on sale at the Technical Papers Desk and Publications Display Booth on the Mezzanine of the Statler Hilton Hotel during the Meeting. Price: $2.50, or $2.00 in coupons. These papers also will be printed in separate copy form.

The Temperature Field in a Spherical Shell Having Internal Heat Generation Which Varies With the Radius and the Spherical Angle,[3] by *George Sonnemann* and *D. J. DiLeonardo*, Univ. of Pittsburgh

Thermoelectric Generators With Surface Heat Loss, by *H. B. Nottage*, Univ. of California, *P. S. Starrett* and *P. L. Winksell*, Lockheed California Co., Div. of Lockheed Aircraft Corp. (Paper No. 61—WA-46)

On the Solution of the Diffusion Equation With a Heat Source, by *S. A. Hovanessian*, California Res. Corp. (Paper No. 61—WA-17)

MONDAY, NOVEMBER 27 2:30 p.m.

Jointly With Petroleum and Power

See Petroleum 2

3 MONDAY, NOVEMBER 27 8:00 p.m.

Panel Discussion: Heat-Transfer Temperature Measurement and Control in Heat-Treating Furnaces

J. Huebler, Midland-Ross Corp.
C. L. Feng, Selas Corp. of America
C. O. Pedersen, Gen. Elec. Co.
W. H. Christiansen, Gen. Elec. Co.
H. M. Short, Aluminum Co. of America
A. H. El Wasiri, U. S. Steel Corp.
P. Anderson, Wallingford Steel Co.

4 TUESDAY, NOVEMBER 28 9:30 a.m.

Plasma Jet Technology Symposium—1

Diffusion and Chemical Surface Catalysis in a Low-Temperature Plasmajet, by *D. E. Rosner*, AeroChem Res. Labs., Inc. (Paper No. 61—WA-160)

Plasma Heating of a Supersonic Gas Stream,[3] by *J. C. Williams, 3rd*, *R. L. Chuan*, *F. O. Smetana*, and *P. C. Wilber*, Univ. of Southern California Engrg. Center

Electric-Arc Jets for Producing Gas Streams With Negligible Contamination,[3] by *C. E. Shepard* and *Warren Winovich*, NASA, Ames Res. Center

High-Pressure Arc Jets,[3] by *Frank Martinek* and *J. W. Reid*, Gen. Elec. Co.

5 TUESDAY, NOVEMBER 28 2:30 p.m.

Plasma Jet Technology Symposium—2

Infrared Techniques for Temperature Measurement in Plasmajets, by *R. H. Tourin*, The Warner & Swasey Co. (Paper No. 61—WA-170)

Radiation Heat Transfer During Re-Entry,[3] by *Bennett Kivel*, Avco-Everett Res. Lab.

A Burner With an Electrical Discharge Superimposed on the Combustion Flame,[3] by *D. L. Richardson*, Arthur D. Little, Inc., and *Bela Karlovits*, Combustion & Explosives Res., Inc.

Heat Transfer From Partially Ionized Gases in the Presence of an Axial Magnetic Field, by *V. J. Raelson*, Illinois Inst. of Tech., Armour Res. Foundation, and *P. J. Dickerman*, The Univ. of Chicago (Paper No. 61—WA-163)

The Effects of Hall and Ion Slip on the Electrical Conductivity of Partially Ionized Gases for Magnetohydrodynamic Re-Entry Vehicle Application, by *M. J. Brummer*, Gen. Elec. Co. (Paper No. 61—WA-176)

6 TUESDAY, NOVEMBER 28 8:00 p.m.

Panel Discussion: Plasma Jet Symposium

J. M. Bonneville, Arthur D. Little, Inc.
J. N. Kotanchik, NASA, Langley Res. Center
T. B. Reed, M.I.T.
Richard John, AVCO Corp
R. C. Eschenbach, Linde Co., Union Carbide Corp.
W. R. Warren, Gen. Elec. Co.
J. R. Wheaton, Dartmouth College
R. C. Dean, Jr., Dartmouth College

7 WEDNESDAY, NOVEMBER 29 9:30 a.m.

Convection

Unsteady Natural Convection in the Vicinity of a Doubly Infinite Vertical Plate, by *J. A. Schetz*, Gen. Applied Science Lab., and *Roger Eichhorn*, Princeton Univ. (Paper No. 61—WA-162)

Combined Free and Forced Convective Flow in Vertical Circular Tubes—Experiments With Water and Oil, by *G. A. Kemeny* and *E. V. Somers*, Westinghouse Elec. Corp. (Paper No. 61—WA-161)

Effect of Arbitrary Nonsteady Wall Temperature on Incompressible Heat Transfer, by *Theodore Goodman*, Allied Res. Associates, Inc. (Paper No. 61—WA-182)

Laminar Heat Transfer in Tubes Under Slip-Flow Conditions, by *E. M. Sparrow* and *S. H. Lin*, Univ. of Minnesota (Paper No. 61—WA-165)

Official Notice—
ASME Business Meeting

The Annual Business Meeting of the members of The American Society of Mechanical Engineers will be held on Monday afternoon, Nov. 27, 1961, at 4:45 p.m., at the Statler Hilton Hotel, New York, N. Y., as part of the Winter Annual Meeting of the Society.

Members are urged to attend.

Laminar Forced Convection of Liquids in Tubes With Variable Viscosity, by *Kwang-Tsu Yang*, Univ. of Notre Dame (Paper No. 61—WA-166)

8 WEDNESDAY, NOVEMBER 29 2:30 p.m.

Convection With Vibrations

The Local Heat-Transfer Coefficient Around a Heated Horizontal Cylinder in an Intense Sound Field, by *R. M. Fand*, M.I.T., *J. Roos*, High Voltage Engrg. Corp., *Ping Cheng* and *J. Kaye*, M.I.T. (Paper No. 61—WA-172)

Heat Transfer From an Oscillating Horizontal Wire to Water, by *F. K. Deaver*, *W. R. Penney*, and *T. B. Jefferson*, Univ. of Arkansas (Paper No. 61—WA-178)

Effectiveness and Heat Transfer for a Turbulent Boundary Layer With Tangential Injection and Variable Free Stream Velocity, by *R. A. Seban* and *L. H. Back*, Univ. of California (Paper No. 61—WA-156)

Forced Convection Heat Transfer From a Uniformly Heated Cylinder, by *H. C. Perkins, Jr.*, and *George Leppert*, Stanford Univ. (Paper No. 61—WA-173)

Laminar Free Convection Boundary-Layer Perturbations Due to Transverse Wall Vibration, by *R. J. Schoenhals*, Purdue Univ., and *J. A. Clark*, Univ. of Michigan (Paper No. 61—WA-174)

9 THURSDAY, NOVEMBER 30 9:30 a.m.

Change of Phase and Two-Phase Flow

An Experimental Investigation of the Mean Liquid Film Thickness and the Characteristics of the Interfacial Surface in Annular, Two-Phase Flow,[3] by *D. A. Charvonia*, North American Aviation, Inc.

Transient Pool Boiling of Water on a Vertical Surface With a Step in Heat Generation, by *Henry Lurie*, Atomics International, and *H. A. Johnson*, Univ. of California (Paper No. 61—WA-164)

On the Size Range of Active Nucleation Cavities on a Heating Surface, by *Y. Y. Hsu*, NASA, Lewis Res. Center (Paper No. 61—WA-177)

Pressure Drop for Flowing Vapors Condensing in a Straight Horizontal Tube,[3] by *C. J. Barocsy* and *V. D. Sanders*, North American Aviation, Inc.

10-A THURSDAY, NOVEMBER 30 2:30 p.m.

Heat Exchangers

Convection Heat Transfer and Pressure Drop of Air Flowing Across In-Line Tube Banks at Close Back Spacings,[3] by *H. N. Fairchild*, Cornell Univ., and *C. P. Welch*, The Babcock & Wilcox Co.

A Systematic Design Approach for a Multistream Exchanger With Interconnected Wall,[3] by *S. Kao*, The M. W. Kellogg Co.

Error Estimates for Flat Plate Approximations in the Impedance Analysis of Radial Heat Conduction in Circular Symmetric Solids,[3] by *C. E. Murphey, Jr.*, Univ. of Texas

Comparison of Dynamic Models of a Superheater, by *Mark Enns*, Westinghouse Elec. Corp. (Paper No. 61—WA-171)

Dynamics of a Counterflow Heat Exchanger,[3] by *D. T. Beecher*, Westinghouse Elec. Corp.

10-B THURSDAY, NOVEMBER 30 2:30 p.m.

A Mixing Length Correlation of Turbulent Vortex Data,[3] by *R. G. Ragsdale*, NASA

Axially Symmetric Laminar Free Mixing With Large Swirl,[3] by *M. H. Steiger* and *M. H. Bloom*, Polytechnic Inst. of Brooklyn

An Electrical Boiler Tube Heater for Use at Rates Up to 400,000 Btu's/hr/sq ft,[3] by *C. E. Moeller*, *S. D. Hadley*, and *W. E. Snyder*, Midwest Res. Inst.

The Temperature Distribution in a Slab Generating Heat With Certain Specified Functions of Temperature, and Having Conductivity a Linear Function of Temperature,[3] by *M. H. Cobble*, Univ. of Delaware

HUMAN FACTORS SESSIONS

MONDAY, NOVEMBER 27 9:30 a.m.

Jointly With Safety and Air-Pollution Controls

See Safety 1

MONDAY, NOVEMBER 27 2:30 p.m.

Jointly With Safety, Production Engineering, and Machine Design

See Safety 2

1 WEDNESDAY, NOVEMBER 29 9:30 a.m.

Interaction of Life Sciences With Engineering

Development of Engineering Techniques Related to the Human Body,[3] by *Samuel Alderson*, Alderson Res. Labs.

A Study of Performance Decrement in Simulated Complex Task Situations in Simulated Environments,[3] by *H. H. Jacobs* and *G. E. Teal*, Public Service Res., Inc.

Automation, and Engineers' Concepts of Operators,[3] by *R. T. Eckenrode*, Dunlap & Associates, Inc.

2 WEDNESDAY, NOVEMBER 29 2:30 p.m.

Panel Discussion: Role of Life Sciences in Engineering Education

P. M. Fitts, Univ. of Michigan
Daniel Howland, Ohio State Univ.
W. C. Schreiner, The M. W. Kellogg Co.
Renato Contini, New York Univ.

HYDRAULIC SESSIONS

1-A MONDAY, NOVEMBER 27 9:30 a.m.

Flow Over an Inclined Plate, by *F. H. Abernathy*, Harvard Univ. (Paper No. 61—WA-124)

Reconsideration of the Annulus Flow Problems in Axial Turbomachinery, by *G. L. Mellor*, Princeton Univ. (Paper No. 61—WA-186)

A Hodograph Design Method for Compressible Flow Problems, by *M. J. Cohen*, Northampton College of Advanced Tech., London, England (Paper No. 61—WA-97)

1-B MONDAY, NOVEMBER 27 9:30 a.m.

Water Hammer, Speed Regulation, and Operation-Stability Studies,[3] by *C. T. Scott*, Corps of Engrs.

Contribution to the Study of Francis Turbine Runner Design,[3] by *Theodore Bovet*, École Polytechnique of Univ. of Lausanne, Lausanne, Switzerland; Charmilles Engrg. Works, Geneva, Switzerland

Analysis of Runout Faults in Hydraulic Turbine-Generator Assemblies,[3] by *L. M. Boyd* and *P. A. Soicher*, Dominion Engrg. Co. Ltd., Montreal, Que., Canada

2-A MONDAY, NOVEMBER 27 2:30 p.m.

Radial Forces in a Pump Impeller, Caused by a Volute Casing, by *G. T. Csanady*, Essex College, Assumption Univ. of Windsor, Ont., Canada (Paper No. 61—WA-77)

The Problems of Sealing Hydrogen Peroxide for Ram-Jets: in a 3000 F Environment, by *R. J. Matt*, Thompson Ramo Wooldridge, Inc. (Paper No. 61—WA-76)

Cavitation Criterion for Dissimilar Centrifugal Pumps, by *A. J. Stepanoff* and *H. A. Stahl*, Ingersoll-Rand Co. (Paper No. 61—WA-139)

2-B MONDAY, NOVEMBER 27 2:30 p.m.

Viscosity and Boundary Effects in the Dynamic Behavior of Hydraulic Systems, by *Hirsh Cohen* and *Yih-O Tu*, IBM Res. Center (Paper No. 61—WA-48)

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[3] Paper not available—see box on page 112.

The Schlieren Method Applied to Flow Visualization in a Water Tunnel, by *R. E. Bland* and *T. J. Pelick,* Pennsylvania State Univ. (Paper No. 61—WA-47)

Stability and Transition of the Free-Convection Layer Along a Vertical Flat Plate,[3] by *A. A. Szewczyk,* Univ. of Maryland

3-A TUESDAY, NOVEMBER 28 9:30 a.m.

Cavitation in Turbopumps—Part 1, by *A. J. Acosta,* California Inst. of Tech., and *L. B. Stripling,* Rocketdyne (Paper No. 61—WA-112)

Cavitation in Turbopumps—Part 2, by *L. B. Stripling,* Rocketdyne (Paper No. 61—WA-98)

3-B TUESDAY, NOVEMBER 28 9:30 a.m.

Two-Dimensional and Three-Dimensional Radial-Type Boundary-Layer Flows About a Flat Plate, by *J. F. Bott,* Harvard Univ., and *D. M. Benenson,* Westinghouse Res. Labs. (Paper No. 61—WA-194)

An Experimental Study of the Vortex in the Cyclone Separator, by *J. L. Smith, Jr.,* M.I.T. (Paper No. 61—WA-189)

An Analysis of the Vortex Flow in the Cyclone Separator, by *J. L. Smith, Jr.,* M.I.T. (Paper No. 61—WA-188)

4-A TUESDAY, NOVEMBER 28 2:30 p.m.

Effect of Cavitation on the Accuracy of Herschel-Type Venturi Tubes, by *F. Numachi, R. Kobayashi,* and *S. Kamiyama,* Tohoku Univ., Sendai, Japan (Paper No. 61—WA-99)

On Cavitation Produced by a Vortex Trailing From a Lifting Surface, by *B. W. McCormick, Jr.,* Pennsylvania State Univ. (Paper No. 61—WA-100)

Surge Pressures in Liquid Transfer Lines, by *I. M. Sarlat* and *T. L. Wilson,* Douglas Aircraft Co., Inc. (Paper No. 61—WA-79)

4-B TUESDAY, NOVEMBER 28 2:30 p.m.

Two-Dimensional Laminar Boundary-Layer Flow Within a Radial Diffuser, by *D. M. Benenson,* Westinghouse Res. Labs., and *J. F. Bott,* Harvard Univ. (Paper No. 61—WA-193)

An Experimental Study of Radial Flow of Air Between Parallel Disks,[3] by *J. A. Paivanas,* Linde Co., and *Theodor Ranov,* The Univ. of Buffalo School of Engrg.

Flow Regimes in Curved Subsonic Diffusers, by *R. W. Fox,* Purdue Univ., and *S. J. Kline,* Stanford Univ. (Paper No. 61—WA-191)

5 WEDNESDAY, NOVEMBER 29 9:30 a.m.

Symposium

Factors Influencing the Selection of Compression Equipment,[3] by *W. J. Gately,* Air Reduction Sales Co.

Oxygen-Compression Qualities,[3] by *W. E. Tipping, Jr.,* E. I. du Pont de Nemours & Co., Inc.

Reciprocating Oxygen Compressors,[3] by *R. W. Harvey,* Linde Co.

Selection and Operation of Air-Plant Compression Equipment,[3] by *B. F. Wobker,* Air Products, Inc.

Summary of Operating Experience With Oxygen-Plant Compression,[3] by *E. A. Kelly,* Hydrocarbon Res., Inc.

6 WEDNESDAY, NOVEMBER 29 2:30 p.m.

Partial Flow in Centrifugal Compressors, by *N. Van Le,* AiResearch Mfg. Co. (Paper No. 61—WA-135)

Prediction of Axial-Flow Turbomachine Performance by Blade-Element Methods, by *G. K. Serovy* and *J. C. Lysen,* Iowa State Univ. (Paper No. 61—WA-134)

THURSDAY, NOVEMBER 30 2:30 p.m.

Jointly With Oil and Gas Power

See Oil and Gas Power 2

JUNIOR SESSION

TUESDAY, NOVEMBER 28 8:00 p.m.

Patents and Professional Development

The United States Patent System,[3] by *J. F. Hanifin,* IBM Corp.

The Value of Patents,[3] by *L. E. Marn,* The Lummus Co.

The Importance of Prior Art Searches—The U. S. Patent Office and Technical Libraries,[3] by *H. S. White,* IBM Command Control Center

LUBRICATION SESSIONS

WEDNESDAY, NOVEMBER 29 9:30 a.m.

Jointly With Research Committee on Lubrication

See Research Committee on Lubrication

1 WEDNESDAY, NOVEMBER 29 2:30 p.m.

Lubrication Review—Developments in Bearings and Lubricants for 1960–1961:

Rolling-Element Bearings,[3] by *J. C. Lawrence,* SKF Industries, Inc.

Gears and Gear Lubrication,[3] by *W. J. Derner,* Curtiss-Wright Corp.

Fluid-Film Bearings,[3] by *R. L. Wehe,* Cornell Univ.

Friction and Wear,[3] by *R. A. Burton,* Southwest Res. Inst.

Metalworking Lubrication,[3] by *E. Hitchcock,* Rustlick Corp.

Automotive Lubricants,[3] by *H. A. Hartung,* Consultant, West Collingswood, N. J.

Lubricants Properties,[3] by *A. A. Schwartz,* Gen. Elec. Co.

Report on the 1961 Spring Lubrication Symposium,[3] by *W. J. Anderson,* NASA, Lewis Res., Center

Report on the Joint ASME-ASLE Lubrication Conference,[3] by *V. S. Wagner,* DeLaval Steam Turbine Co.

2 THURSDAY, NOVEMBER 30 9:30 a.m.

Calculation of Lubricant Temperatures in High-Speed Cylindrical Rolling Contacts, by *A. D. St. John,* Midwest Res. Inst. (Paper No. 61—WA-157)

A Journal-Bearing Analysis With Application to Liquid-Metal Lubricants, by *W. T. Snyder,* State Univ. of New York, and *L. N. Conner, Jr.,* North Carolina State College (Paper No. 61—WA-83)

Influence of Housing Design on Lubricant Flow in Regreasable Ball Bearings, by *E. R. Booser, D. A. Smeaton,* and *J. Cothren,* Gen. Elec. Co. (Paper No. 61—WA-65)

On the Stability of Rotors in Plain Cylindrical Journal Bearings, by *B. Sternlicht* and *G. W. Rentsepis,* Gen. Elec. Co. (Paper No. 61—WA-196)

RESEARCH COMMITTEE ON LUBRICATION SESSION

WEDNESDAY, NOVEMBER 29 9:30 a.m.

Jointly With Lubrication

Bearing Rotor Dynamics

Rotor-Bearing Dynamics With Emphasis on Attenuation, by *B. Sternlicht* and *J. W. Lund,* Gen. Elec. Co. (Paper No. 61—WA-68)

The Simulation of Bearing Whirl on an Electronic-Analog Computer, by *F. W. Ocvirk,* Cornell Univ., and *U. D. Jennings,* E. I. Dupont Co., Inc. (Paper No. 61—WA-74)

A Preliminary Study of Whirl Instability for Pressurized Gas Bearings, by *R. H. Larson,* The Bendix Corp., and *H. H. Richardson,* M.I.T. (Paper No. 61—WA-67)

A Note on the Work Done on the Journal by the Forces Exerted by a Compressible Lubricant in a Journal Bearing, by *Hillel Poritsky,* Gen. Elec. Co. (Paper No. 61—WA-133)

MACHINE DESIGN SESSIONS

MONDAY, NOVEMBER 27 2:30 p.m.

Jointly With Safety, Production Engineering, and Human Factors

See Safety 2

1 TUESDAY, NOVEMBER 28 2:30 p.m.

Some Simplified Solutions for Relatively Stiff Beams on Elastic Foundations, by *B. W. Shaffer,* New York Univ. (Paper No. 61—WA-3)

Synthesis of the Six-Link Plane Mechanisms by Numerical Analysis, by *C. W. McLarnan,* The Ohio State Univ. (Paper No. 61—WA-86)

Engineering Analysis of a Wire-In-Tube Switching Device,[3] by *R. A. DiTaranto,* Drexel Inst. of Tech.

2 TUESDAY, NOVEMBER 28 8:00 p.m.

Determination of the Closing Time of a Solenoid Actuated Mechanism, by *J. R. Baumgarten,* Nat. Cash Register Co. (Paper No. 61—WA-129)

Design of an Epicyclic Gear Train by Use of a Digital Computer, by *D. E. Clancy* and *D. R. Doering,* Nat. Cash Register Co. (Paper No. 61—WA-126)

A Study of Friction Loss for Spur Gear Teeth, by *Lu-nien Tso,* Lieut., Chinese Navy, Taiwan, China, and *R. W. Prowell,* U. S. Naval Postgraduate School, *presently with* Middle East Technical Univ., Ankara, Turkey. (To be presented by *T. F. Eserkaln,* Eserkaln & Associates) (Paper No. 61—WA-85)

3 WEDNESDAY, NOVEMBER 29 9:30 a.m.

Torsional and Longitudinal Vibrations of Variable Section Bars, by *E. T. Cranch,* Cornell Univ., and *O. H. Griffith,* Nortronics, Div. of Northrop Corp. (Paper No. 61—WA-75)

The Dynamic Response of Nonlinear Hydraulic Damping Device, by *G. H. Bussard, II,* Duke Univ. (Paper No. 61—WA-205)

A Method for Reducing the Number of Degrees of Freedom in Mathematical Models of Damped Linear Dynamic Systems, by *S. E. Staffeld,* Chrysler Corp. (Paper No. 61—WA-118)

4 WEDNESDAY, NOVEMBER 29 2:30 p.m.

Stresses and Deflection in a Cylindrical Shell Subjected to Concentrated Radial Loads, by *R. F. Steidel, Jr.,* Univ. of California, and *Maurice Galasso,* Aerojet-Gen. Nucleonics (Paper No. 61—WA-2)

Load-Deflection Behavior of Conical Spiral Compression Springs, by *W. J. Worley* and *Han-chung Wang,* Univ. of Illinois (Paper No. 61—WA-128)

Shrink Fits of Moderately Long Bands on Thin-Walled Cylinders, by *B. Paul,* Bell Telephone Labs. (Paper No. 61—WA-78)

5 THURSDAY, NOVEMBER 30 9:30 a.m.

Combination of Solutions of the Torsion Problem by Means of a Connection Function, by *W. J. Carter,* The Univ. of Texas (Paper No. 61—WA-127)

Deflections and Stability of Fluid-Carrying Tubes and Hoses, by *W. J. Carter,* The Univ. of Texas (Paper No. 61—WA-123)

Analysis of Two-Dimensional Motion Resisted by Coulomb Friction, by *T. P. Goodman,* Gen. Elec. Co. (Paper No. 61—WA-113)

6 THURSDAY, NOVEMBER 30 2:30 p.m.

An Exploratory Study of Stress Concentrations in Thermal Shock Fields, by *Herbert Becker,* New York Univ. (Paper No. 61—WA-84)

Stability of the High-Speed Journal Bearing Under Steady Load—Part 1, The Incompressible Film, by *M. M. Reddi,* The Franklin Inst. Labs., and *P. R. Trumpler,* Univ. of Pennsylvania (Paper No. 61—WA-87)

Solution of a Kinematic Problem Necessary for the Design of Valve-Opening Mechanisms for Correctly Apportioning Three Fluids in a Chemical Apparatus, by *A. E. R. de Jonge,* City College of New York (Paper No. 61—WA-154)

MAINTENANCE SESSIONS

1 THURSDAY, NOVEMBER 30 9:30 a.m.

Jointly With Rubber and Plastics

Reinforced Plastics for Chemical Equipment,[3] by *H. E. Atkinson,* E. I. du Pont de Nemours & Co., Inc.

Maintenance Problems Encountered With Mechanical Seals,[3] by *T. E. Alexander,* Power Packing Co.

Ultrasonic Inspection of Forgings in Service,[3] by *Herman Greenberg,* Westinghouse Elec. Corp.

2 THURSDAY, NOVEMBER 30 2:30 p.m.

Principles and Applications of Nondestructive Testing,[3] by *D. D. Dodge,* Ford Motor Co.

The Place for Nondestructive Tests in the Field of Plant and Equipment Overhaul, by *H. G. Bogart,* Magnaflux Corp. (Paper No. 61—WA-209)

Reducing Maintenance Costs Through Nondestructive Testing,[3] by *C. E. Lautzenheiser,* The Dow Chemical Co.

MANAGEMENT SESSIONS

TUESDAY, NOVEMBER 28 9:30 a.m.

Administration of the Change Control Function,

by *D. D. Acker*, Autonetics, Div. of North American Aviation, Inc. (Paper No. 61—WA-130)

The Management of Advanced Technology,[3] by *P. O. Gaddis*, Westinghouse Atomic Power Div.

TUESDAY, NOVEMBER 28 2:30 p.m.

Jointly With Professional Practice Committee

See Professional Practice Committee

TUESDAY, NOVEMBER 28 8:00 p.m.

Jointly With Production Engineering

See Production Engineering 3

MATERIALS HANDLING

SESSIONS

1 MONDAY, NOVEMBER 27 9:30 a.m.

Pumping Dry Solids,[3] by *G. H. Zimmer*, Robbins & Myers, Inc.

Unique Computer-Controlled Batching, by *C. W. Hibscher* and *R. J. Phillips*, Toledo Scale Corp. (Paper No. 61—WA-183)

2 MONDAY, NOVEMBER 27 2:30 p.m.

Bulk-Materials Handling of Alumina, by *R. F. West*, Reynolds Metals Co. (Paper No. 61—WA-90)

There will be a presentation of a color film, with sound, prepared by the Butler Manufacturing Company, which describes an interesting and highly ingenious approach to the study of the flow of bulk materials from storage bins.

MECHANICAL ENGINEERING DEPARTMENT HEADS

SESSIONS

TUESDAY, NOVEMBER 28 9:30 a.m.

Jointly With Safety

See Safety 3

TUESDAY, NOVEMBER 28 8:00 p.m.

Symposium

The Role of Digital Computers in Mechanical-Engineering Education,[2] by *R. J. Grosh*, Purdue Univ.

The Use of Laboratory in Mechanical-Engineering Instruction,[2] by *S. J. Kline*, Stanford Univ.

Report of the North Carolina State NSF Study on Mechanical-Engineering Laboratory,[2] by *G. L. Goglia*, North Carolina State College

Report of the Lehigh University NSF Study on Design and Laboratory in Mechanical-Engineering Education,[2] by *T. E. Jackson*, Lehigh Univ.

Report of Proposed NSF-Sponsored Studies of Mechanical-Engineering Education.[2] *Principal investigators will report on the status of their proposed NSF studies of mechanical-engineering education, describe the philosophy of the study, and outline operational details.*

METALS ENGINEERING

SESSIONS

MONDAY, NOVEMBER 27 9:30 a.m.

Jointly With Plastic Flow of Metals and Production Engineering

See Plastic Flow of Metals

1 MONDAY, NOVEMBER 27 2:30 p.m.

Cumulative Fatigue Damage With Random Loading, by *R. R. Gatts*, Gen. Elec. Co. (Paper No. 61—WA-31)

Design of Pressure Vessels for Low-Cycle Fatigue, by *B. F. Langer*, Westinghouse Elec. Corp. (Paper No. 61—WA-18)

Experimental Support for Generalized Equation Predicting Low-Cycle Fatigue, by *J. F. Tavernelli* and *L. F. Coffin, Jr.*, Gen. Elec. Co. (Paper No. 61—WA-199)

The Failure of 304 Stainless Steel by Thermal Strain Cycling at Elevated Temperature, by *A. E. Carden* and *J. H. Sodergren*, Univ. of Alabama (Paper No. 61—WA-200)

Cracking in Low-Cycle Torsional Fatigue With Increasing Strain Amplitudes,[3] by *F. A. McClintock*, M.I.T., and *A. M. Willner*, Cornell Univ.

Low-Cycle Fatigue Design Procedures,[3] by Subcommittee on Low-Cycle Fatigue of the ASME Research Committee for Prevention of Fracture in Metals

2 TUESDAY, NOVEMBER 28 9:30 a.m.

Trends and Implications of Data on Notched-Bar Creep Rupture,[3] by *H. R. Voorhees* and *J. W. Freeman*, Univ. of Mich., and *A. Herzog*, Wright-Patterson AFB, Ohio

The Effect of a "V" Notch on the Tensile Creep Behavior of Cr-Mo Steel, by *Yoshitada Suezawa* and *Hidemitsu Hojo*, Tokyo Inst. of Tech., Tokyo, Japan (Paper No. 61—WA-16)

Effect of Specimen Size in Notch-Rupture Testing,[3] by *M. J. Manjoine*, Westinghouse Res. Labs.

Notch-Rupture Behavior as Influenced by Specimen Size and Preparation,[3] by *W. H. Couts, Jr.*, Gen. Elec. Co., and *J. W. Freeman*, Univ. of Mich.

Influence of Ductility on Creep Rupture Under Multiaxial Stresses,[3] by *Walter Sawert*, Gen. Elec. Co., and *H. R. Voorhees*, Univ. of Mich.

Notched-Bar Creep Rupture of a Cast Heat-Resistant Alloy at Temperatures Where Ductility Is Limited,[3] by *D. K. Hanink*, Gen. Motors Co., and *H. R. Voorhees*, Univ. of Mich.

Design of Apparatus for Constant-Stress or Constant-Load Creep Tests,[3] by *Frank Garofalo*, *O. Richmond*, and *W. F. Domis*, U. S. Steel Corp. Res. Center

An Empirical Creep Law From a Single Test,[3] by *I. Finnie*, Univ. of California

Cumulative Damage in Creep-Rupture Tests of a Carbon Steel,[3] by *P. N. Randall*, American Oil Co.

Deformation of Uranium Under Constant Load and Cyclic Temperature,[3] by *K. R. Merckx* and *K. R. Wheeler*, Gen. Elec. Co.

3 TUESDAY, NOVEMBER 28 2:30 p.m.

Why and What the Mechanical-Engineering Student in Materials Engineering Should Know About:

Physics of Solids,[2] speaker to be announced

Chemistry of Solids,[2] by *W. Robertson*, Yale Univ.

Mechanics of Solids,[2] by *J. Marin*, Pennsylvania State Univ.

Metals,[2] by *M. E. Shank*, Pratt & Whitney Aircraft Co.

Polymers,[2] by *A. S. Michaels*, M.I.T.

Ceramics,[2] by *J. R. Tinklepaugh* and *R. Campbell*, Alfred Univ.

TUESDAY, NOVEMBER 28 2:30 p.m.

Jointly with Production Engineering

See Production Engineering 2

4 WEDNESDAY, NOVEMBER 29 9:30 a.m.

Plastic Analysis of the Instability of Pressure Vessels Subjected to Internal Pressure and Axial Load, by *R. P. Felgar*, Space Tech. Labs., Inc. (Paper No. 61—WA-144)

Mechanical Models for Tubular Reactor Fuel Elements, by *K. R. Merckx*, Gen. Elec. Co. (Paper No. 61—WA-198)

Crack Propagation in Aluminum-Foil Laminates, by *C. D. Mote, Jr.*, and *Joseph Frisch*, Univ. of California (Paper No. 61—WA-131)

Low-Temperature Properties of K-Monel, Inconel-X, Rene 41, Haynes 25, and Hastelloy B Sheet Alloys,[1] by *J. F. Watson* and *J. L. Christian*, Gen. Dynamics/Astronautics (Paper No. 61—WA-12)

Dynamic Elastic Modulus Values at Room and Elevated Temperatures of Some Materials for Missile Applications,[1] by *C. L. Theberge* and *T. W. Gibbs*, Avco Corp. (Paper No. 61—WA-13)

THURSDAY, NOVEMBER 30 2:30 p.m.

Jointly With Applied Mechanics

See Applied Mechanics 9

NUCLEAR ENGINEERING

SESSIONS

TUESDAY, NOVEMBER 28 2:30 p.m.

Jointly With Safety

See Safety 4

1 WEDNESDAY, NOVEMBER 29 9:30 a.m.

Superheat Developments in Nuclear Power Plants

Design Features of the BONUS (Boiling Nuclear Superheat) Nuclear Power Station,[3] by *A. S. Jameson*, Gen. Nuclear Engrg. Corp.

The Reactor and Plant Design for the ESADA Vallecitos Experimental Superheat Reactor,[3] by *John Barnard*, Gen. Elec. Co.

Direct-Cycle Nuclear Superheat for Modern Steam Turbines,[3] by *J. H. Wright*, Westinghouse Atomic Power Dept.

2 WEDNESDAY, NOVEMBER 29 2:30 p.m.

Reactor Systems

The Experimental Beryllium-Oxide Reactor,[3] by *W. C. Moore*, Gen. Dynamics/Gen. Atomic Div.

The 50-Mwe Prototype Organic Power Reactor,[3] by *C. W. Wheelock* and *G. S. Budney*, Atomics International

Design Aspects of the Saxton Radioactive Waste-Disposal Facility,[3] by *E. R. Hottenstein*, Gilbert Associates, Inc.

Pressure-Tube Designs for Nuclear Reactors,[3] by *A. G. Thorp*, 2nd, Westinghouse Elec. Corp.

3 THURSDAY, NOVEMBER 30 9:30 a.m.

Reactor Systems Components

Cleaning Nuclear Power-Plant Equipment With Sulfamic Acid, by *Kurt Jakobson*, The Martin Co. (Paper No. 61—WA-44)

Predicting Maximum Pressures in Pressure-Suppression Reactor Containment,[3] by *C. P. Ashworth* and *D. B. Barton*, Pacific Gas & Elec. Co., *E. Janssen* and *C. H. Robbins*, Gen. Elec. Co.

Steam Generator-Superheater for Molten-Salt Power Reactor,[3] by *B. W. Kinyon* and *G. D. Whitman*, Oak Ridge Nat. Lab.

4 THURSDAY, NOVEMBER 30 2:30 p.m.

Reactor Operating Experience

Equipment Performance and Operating Experience at the Yankee Atomic Electric Plant,[3] by *G. A. Reed*, Yankee Atomic Elec. Co.

Shippingport Operating Experience,[3] by *L. R. Love*, Duquesne Light Co.

Dresden Operating Experience,[3] *speaker to be announced*

OIL AND GAS POWER

SESSIONS

1 THURSDAY, NOVEMBER 30 9:30 a.m.

The Free Piston Engine for All Fuels—The World-Wide SIGMA Experience, by *Maurice Barthalon*, SIGMA (Société Industrielle Générale de Mécanique Appliquée), Paris, France (Paper No. 61—WA-63)

Constant Volume Adiabatic Combustion of Methane and Air, by *A. R. Foster*, Northeastern Univ. (Paper No. 61—WA-26)

2 THURSDAY, NOVEMBER 30 2:30 p.m.

Jointly With Hydraulic

Compressor-Installation Design Utilizing an Electro-Acoustical System Analog,[3] by *G. Damewood* and *Walter Nimitz*, Southwest Res. Inst.

Damping of Torsional Vibration in Engine-Compressor Drives,[3] by *C. M. Lowell*, Worthington Corp.

PETROLEUM

SESSIONS

1 MONDAY, NOVEMBER 27 9:30 a.m.

Jointly With Heat Transfer and Power

Selecting of Cooling Towers for Steam-Condensing Turbines,[3] by *D. R. Baker*, The Marley Co.

Effect of Exhaust Pressure on Cost and Performance of Condensing and Automatic-Extraction Condensing Steam Turbines,[3] by *Stanley Styrna*, Gen. Elec. Co.

2 MONDAY, NOVEMBER 27 2:30 p.m.

Jointly With Heat Transfer and Power

Effect of Cooling Water Supplies on the Price

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[2] Not to be printed.

[3] Paper not available—see box on page 112.

and Performance of Surface Condensers,[3] by *P. J. Hamm*, C. H. Wheeler Mfg. Co.

Economic Selection of Exhaust Pressure for Condensing Turbines and Its Effect on Condensers, Cooling Towers, and Other Related Equipment,[3] by *W. B. Wilson* and *D. L. E. Jacobs*, Gen. Elec. Co.

WEDNESDAY, NOVEMBER 29 9:30 a.m.

Jointly With Applied Mechanics

See Applied Mechanics 6

PLASTIC FLOW OF METALS SESSION

MONDAY, NOVEMBER 27 9:30 a.m.

Jointly With Metals Engineering and Production Engineering

Rapid Deformation

Recent Developments in High-Energy-Rate Forming,[1] by *F. W. Boulger*, Battelle Memorial Inst.

Recent Developments in High-Speed Machining of Metals,[1] by *W. N. Findley*, Brown Univ.

Recent Developments in Impact Extrusion of Aluminum,[1] by *M. A. Ziegler*, Aluminum Co. of America

Recent Developments in High-Speed Rolling,[1] by *L. F. Coffin, Jr.*, Gen. Elec. Res. Lab.

POWER SESSIONS

MONDAY, NOVEMBER 27 9:30 a.m.

Jointly With Petroleum

See Petroleum 1

MONDAY, NOVEMBER 27 2:30 p.m.

Jointly With Fuels

See Fuels 2

MONDAY, NOVEMBER 27 2:30 p.m.

Jointly With Petroleum and Heat Transfer

See Petroleum 2

TUESDAY, NOVEMBER 28 9:30 a.m.

Jointly With Boiler Feedwater Studies

See Boiler Feedwater Studies 1

TUESDAY, NOVEMBER 28 9:30 a.m.

Jointly With Fuels and Automatic Control

See Fuels 3

TUESDAY, NOVEMBER 28 2:30 p.m.

Jointly With Boiler Feedwater Studies

See Boiler Feedwater Studies 2

TUESDAY, NOVEMBER 28 2:30 p.m.

Jointly With Fuels

See Fuels 4

TUESDAY, NOVEMBER 28 8:00 p.m.

Jointly With Gas Turbine Power

See Gas Turbine Power 6

1 WEDNESDAY, NOVEMBER 29 9:30 a.m.

Dissipation of Heat and the Sharing of Water Resources

Industry's Problems in Sharing Our Water Resources, by *Stanley Moyer*, Philadelphia Elec. Co. (Paper No. 61—WA-141)

The Effects of Heated Discharges on Aquatic Life and Water Use, by *C. B. Wurts*, Consulting Biologists, Inc. (Paper No. 61—WA-142)

Methods for Sharing Our Water Resources, by *R. M. Homan*, *H. C. Schweikart*, and *A. F. Smith, 3rd*, Gilbert Associates, Inc. (Paper No. 61—WA-185)

2 WEDNESDAY, NOVEMBER 29 2:30 p.m.

Industrial Power

Effects of Industry Trends to High Pressure, Temperature, and Capacity on Boiler Design,[3] by *C. T. Smith* and *R. S. Rachford*, The Babcock & Wilcox Co.

The Place of Shop-Fabricated Boilers in Industry, by *M. L. Jones*, E. I. du Pont de Nemours & Co., Inc. (Paper No. 61—WA-89)

Steam Generation From Waste Products,[3] by *C. H. Johnson*, International Paper Co.

Satisfying the Industrial Power Demand, by *T. M. Hendrickson*, Youngstown Sheet & Tube Co. (Paper No. 61—WA-114)

3 THURSDAY, NOVEMBER 30 9:30 a.m.

Steam-Turbine Operation

Use of Valve-Bowl Partition Heating Holes and External Manifolds on Single-Shell Integral Chest Steam Turbines to Reduce Thermal Stresses During Start-Up, by *F. W. Kuehn*, Pennsylvania Power & Light Co. (Paper No. 61—WA-119)

Reducing Thermal Stresses in Turbine Cylinders Subjected to Cyclic Service, by *Walter Sinton* and *R. E. Warner*, Westinghouse Elec. Corp. (Paper No. 61—WA-120)

The New England Electric System Tests Effectiveness of Stop-Valve Bypass in Reducing Thermal-Stress Gradients in Steam Turbines, by *E. F. Walsh*, New England Elec. System, and *R. L. Jackson*, Gen. Elec. Co. (Paper No. 61—WA-121)

Steam-Turbine Governing Stage, Impulse-Blade Vibration Investigation, by *Thomas Vuksta, Jr.*, Allis-Chalmers Mfg. Co. (Paper No. 61—WA-122)

4 THURSDAY, NOVEMBER 30 2:30 p.m.

Developing Techniques for Accelerated Starting of Pulverized-Coal-Fired Units

System Economics and Operating Procedures,[3] by *O. L. Gann*, Illinois Power Co., *G. G. Halfinger* and *R. C. Sherrill*, Combustion Engrg., Inc., and *J. A. Donald*, Sargent & Lundy

Practical Operating Guides,[3] by *G. G. Halfinger* and *R. C. Sherrill*, Combustion Engrg., Inc., *O. L. Gann*, Illinois Power Co., and *J. A. Donald*, Sargent & Lundy

Plant-Design Considerations,[3] by *J. A. Donald*, Sargent & Lundy, *O. L. Gann*, Illinois Power Co., *G. G. Halfinger* and *R. C. Sherrill*, Combustion Engrg., Inc.

The Effects of Nucleate Versus Film Boiling on Heat Transfer in Power-Boiler Tubes,[1] by *H. S. Swenson*, *J. R. Carver*, and *G. Ssocke*, The Babcock & Wilcox Co. (Paper No. 61—WA-201)

POWER TEST CODES SESSION

THURSDAY, NOVEMBER 30 2:30 p.m.

Empirical Determination of Thermocouple Characteristics, by *R. P. Benedict* and *H. F. Ashby*, Westinghouse Elec. Corp. (Paper No. 61—WA-19)

A Practical Method of Determining Response Time of Thermometers in Liquid Baths, by *J. W. Murdock*, *C. J. Folts*, and *Clarence Gregory*, Philadelphia Naval Shipyard (Paper No. 61—WA-32)

An Economic Approach to Plant-Performance Evaluation,[3] by *Paul Matthew* and *W. H. Barr*, Pacific Gas & Elec. Co.

PROCESS INDUSTRIES SESSIONS

1 TUESDAY, NOVEMBER 28 9:30 a.m.

Jointly With American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc.

Psychrometrics and Modern Comfort,[5] by *R. G. Nevins*, Kansas State Univ.

Effect of Psychrometrics on Human Disease: A Study Utilizing the Controlled Climate Chamber,[5] by *J. L. Hollander*, Univ. of Pennsylvania

Physiological Reactions to Psychrometric Extremes,[5] by *L. A. Brouha*, E. I. du Pont de Nemours & Co., Inc.

2 TUESDAY, NOVEMBER 28 2:30 p.m.

Jointly With American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc.

Symposium

The symposium will be on the subject of psychrometrics and the history and development of psychrometric charts. A new psychrometric chart recently adopted by ASHRAE will be described.

Psychrometric Charts in Review,[2] by *D. D. Wile*, Recold Corp.

ASHRAE Psychrometric Chart,[2] by *John Everetts, Jr.*, Charles S. Leopold, Inc.

3 WEDNESDAY, NOVEMBER 29 9:30 a.m.

Jointly With American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc.

The Economic Application of Gas Turbines to Large Tonnage Air-Conditioning Installations, by *C. R. Apits*, Clark Brothers Co., Div. of Dresser Industries (Paper No. 61—WA-202)

Absorption Air Conditioning, by *G. O. Kuhen*, Carrier Corp. (Paper No. 61—WA-116)

Application of Natural Gas Engines to Air Conditioning and Refrigeration,[3] by *R. A. D'Amour*, Waukesha Motor Co.

4 WEDNESDAY, NOVEMBER 29 2:30 p.m.

Panel Discussion: The Rapid Growth of Cryogenics

The past five or six years have witnessed much progress in the application of phenomena occurring at very low temperatures (below −250 C). The state of knowledge and achievements thus far attained point to promising futures in superconductivity, refrigeration, materials, and so on. Realizing the importance of this relatively new area to the mechanical engineer, this session is an attempt to familiarize him with some of the more important aspects of the subject. A panel of four speakers will review briefly superconductivity, superconducting devices, refrigeration and instrumentation, insulation materials, and design principles. An informal discussion will follow.

J. C. Fisher, Gen. Elec. Res. Lab.
D. R. Young, IBM Components Lab.
A. A. Fowle, Arthur D. Little, Inc.
John Macinko, Nat. Bur. of Standards

PRODUCTION ENGINEERING SESSIONS

MONDAY, NOVEMBER 27 9:30 a.m.

Jointly With Plastic Flow of Metals and Metals Engineering

See Plastic Flow of Metals

MONDAY, NOVEMBER 27 2:30 p.m.

Jointly With Safety, Machine Design, and Human Factors

See Safety 2

1 TUESDAY, NOVEMBER 28 9:30 a.m.

The Brazement—Design and Application,[3] by *R. L. Peaslee*, Wall Colmonoy Corp.

Design and Fabrication of an All-Welded Motor,[3] by *A. S. DePaul*, Westinghouse Elec. Corp.

Designing for Automatic Welding,[3] by *R. A. Wilson*, Lincoln Elec. Co.

2 TUESDAY, NOVEMBER 28 2:30 p.m.

Jointly With Metals Engineering

Some Engineering Applications of Ductile-Iron Castings,[3] by *J. J. Dow* and *S. F. Carter*, American Cast Iron Pipe Co.

Uses of Ductile Iron in Paper-Mill Machinery,[3] by *F. C. Hardick*, The Sandy Hill Iron & Brass Works

Yttrium Nodular Iron,[3] by *J. J. Kanter*, *J. P. Magos*, and *W. L. Meinhart*, Crane Co.

3 TUESDAY, NOVEMBER 28 8:00 p.m.

Jointly With Management

Product Redesign to Reduce Cost and Improve Quality,[3] by *E. J. Welch*, Western Elec. Co.

Reduction in Manufacturing Costs on Medium-to-Light Machines Through Greater Use of Steel and Improved Fabrication Methods,[3] by *R. G. Ericson*, United Shoe Machinery Corp.

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[1] Not presented orally.

[5] ASHRAE paper—copies available a meeting.

[2] Not to be printed.

[3] Paper not available—see box on page 112.

4 WEDNESDAY, NOVEMBER 29 9:30 a.m.

Grinding With Abrasive Disks—Part 1: Test Procedures and Performance Criteria, by *W. A. Mohun*, industrial consultant, Toronto, Ont., Canada (Paper No. 61—WA-69)

Grinding With Abrasive Disks—Part 2: Disk Performance and Dressing Mechanisms, by *W. A. Mohun*, industrial consultant, Toronto, Ont., Canada (Paper No. 61—WA-70)

Grinding With Abrasive Disks—Part 3: Attritious Camber, Glazing, and Rate of Cut, by *W. A. Mohun*, industrial consultant, Toronto, Ont., Canada (Paper No. 61—WA-71)

Grinding With Abrasive Disks—Part 4: Grinding Power and Grinding Temperatures, by *W. A. Mohun*, industrial consultant, Toronto, Ont., Canada (Paper No. 61—WA-72)

5 WEDNESDAY, NOVEMBER 29 2:30 p.m.

Study on Wear of Grinding Wheels, Part 1, Bond Fracture in Grinding Wheels, by *Hiroyuki Yoshikawa*, The Inst. of Physical & Chemical Res., Tokyo, Japan, and *Toshio Sata*, M.I.T. (Paper No. 61—WA-73)

On Determining the Hardness of Grinding Wheels—Part 2,[3] by *L. V. Colwell*, Univ. of Michigan

Diamond Burnishing, by *E. H. Hull*, Gen. Elec. Res. Lab. (Paper No. 61—WA-96)

Basic Investigation of Tool Wear,[1] by *H. Takeyama* and *R. Murata*, The Government Mech. Lab., Tokyo, Japan (Paper No. 61—WA-92)

6 THURSDAY, NOVEMBER 30 9:30 a.m.

Surface Effects and Residual Stresses in Electrolytically Ground Steel, by *J. Frisch* and *R. R. Cole*, Univ. of Calif. (Paper No. 61—WA-94)

The Mechanics of the Coining Process, by *Y. Bocharov*, *S. Kobayashi*, and *E. G. Thomsen*, Univ. of California (Paper No. 61—WA-88)

The Effect of Vibration on Plastic Flow in Coining, by *Y. Bocharov*, *S. Kobayashi*, and *E. G. Thomsen*, Univ. of California (Paper No. 61—WA-91)

7 THURSDAY, NOVEMBER 30 2:30 p.m.

Self-Induced Vibrations in Metal Cutting, by *Paul Albrecht*, The Cincinnati Milling Machine Co. (Paper No. 61—WA-195)

The Effect of Flank Wear on Tool Temperatures in the Machining of Cast Iron,[3] by *B. T. Chao*, *D. R. Jeng*, and *K. J. Trigger*, Univ. of Illinois

The Upper Bound Solution as Applied to Three-Dimensional Extrusion and Piercing Problems, by *C. T. Yang*, IBM (Paper No. 61—WA-93)

PROFESSIONAL PRACTICE COMMITTEE

SESSION

TUESDAY, NOVEMBER 28 2:30 p.m.

Jointly With Management

Professional Integrity of the Engineer as It Applies to Marketing,[3] by *H. R. Mathias*, McGraw-Hill Publishing Co., Inc.

Professional Integrity of the Engineer as It Applies to Design and Research,[3] by *J. F. Young*, Gen. Elec. Co.

Professional Integrity of the Engineer as It Applies to Service,[3] by *J. J. Ragusan*, Combustion Engrg., Inc.

Professional Integrity of the Engineer as It Applies to Purchasing, by *D. S. Gibson*, Worthington Corp. (Paper No. 61—WA-132)

PROPERTIES OF STEAM

SESSION

MONDAY, NOVEMBER 27 2:30 p.m.

Viscosity and Thermal Conductivity of Water: Gaseous and Liquid States, by *R. V. Theiss*, Monsanto Chemical Co., and *George Thodos*, Northwestern Univ. (Paper No. 61—WA-204)

Velocity of Sound Measurements in High-Pressure High-Temperature Steam,[3] by *James Woodburn*, North Carolina State College

Measurement of Viscosity by the Oscillating-Disk Method,[3] by *Joseph Kestin*, Brown Univ.

Measurement of Viscosity of Steam by the Capillary Method,[3] by *O. W. Witzell*, Purdue Univ.

Comments on Measurement of the Joule-Thomson Coefficients of Water,[3] by *B. H. Sage*, *G. N. Richter*, and *H. H. Reamer*, California Inst. of Tech.

Measurements of Thermal Conductivity,[3] by *F. G. Keyes*, M.I.T.

Measurement of the Pressure-Volume-Temperature Relationship,[3] by *E. Whalley*, Nat. Res. Council, Ottawa, Ont., Canada

RAILROAD

SESSIONS

1 WEDNESDAY, NOVEMBER 29 2:30 p.m.

Progress in Railway Mechanical Engineering 1960–1961,[3] by *D. R. Meier*, Gen. Elec. Co.

Unusual Ventilating System Characterizes General Electric's New 2500-Hp Diesel Electric Locomotive, by *J. C. Aydelott*, Gen. Elec. Co. (Paper No. 61—WA-208)

A Comprehensive Engine Cooling System for Diesel Electric Locomotives, by *J. C. Aydelott* and *W. W. Peters*, Gen. Elec. Co. (Paper No. 61—WA-207)

2 THURSDAY, NOVEMBER 30 9:30 a.m.

Relation of Wheel-Tread Wear and Brake-Shoe Wear,[3] by *J. R. Jennings*, Wilson Car Lines, Div. of Wilson & Co., Inc.

Freight-Car Center-Plate Lubrication,[3] by *W. H. Cyr*, Canadian Nat. Ry, Montreal, Que., Canada

Design and Testing of a Self-Supporting Aluminum-Covered Hopper Car,[3] by *R. A. Campbell*, Alcan International Ltd., Montreal, Que., Canada, and *I. H. Jenks*, Aluminum Labs. Ltd., Kingston, Ont., Canada

3 THURSDAY, NOVEMBER 30 2:30 p.m.

The Barber Cushion Tube,[3] by *R. C. Williams*, Standard Car Truck Co., and *S. G. Guins*, The Chesapeake & Ohio Ry Co.

The Design of Cushioning Gears for Rail Car Applications,[3] by *R. L. Hassenauer*, Gen. American Transportation Corp., and *G. E. Novak*, Riverside, Ill.

British Railways Experimental Brake Van (Caboose),[3] by *B. T. Scales*, British Transport Commission, Derby, England

RUBBER AND PLASTICS

SESSIONS

1 MONDAY, NOVEMBER 27 9:30 a.m.

Plastics Processing and Application

Influence of Normal Stress on Creep in Tension and Compression of Polyethylene and Rigid Polyvinyl Chloride Copolymer, by *D. G. O'Connor* and *W. N. Findley*, Brown Univ. (Paper No. 61—WA-35)

Experimental Measurement of Roll-Separating Forces During Milling of Plastics, by *R. H. Carey*, Union Carbide Plastics Co. (Paper No. 61—WA-184)

Effect of Curing Mechanism on the Properties of Reinforced Plastics,[3] by *J. O. Outwater*, Univ. of Vermont

2 MONDAY, NOVEMBER 27 2:30 p.m.

Plastics Processing and Application

Performance of Teflon Fluorocarbon Resins as Bearing Materials,[3] by *J. T. O'Rourke*, *W. D. Lewis* and *R. B. Lewis*, E. I. du Pont de Nemours & Co., Inc.

Anisotropy in Designing With Plastics, by *R. S. Hagan* and *J. V. Schmitz*, Gen. Elec. Co. (Paper No. 61—WA-206)

Present Uses and Future Horizons for Packaging With Thermoformed Cellulose Acetate,[3] by *W. M. Ronayne*, Celanese Plastics Co.

Designing With Pro-fax Polypropylene,[3] by *R. A. Stoltenberg*, Hercules Powder Co.

3 MONDAY, NOVEMBER 27 8:00 p.m.

Rubber Processing and Application

The Ko-Kneader System—A New Concept for Continuous Intensive Mixing,[3] by *R. W. Miler* and *H. F. Irving*, Baker Perkins Inc.

Constrained Layer Damping Applied to Printed Circuit Boards,[3] by *L. J. Schwemmer* and *T. J. Loftus*, Lord Mfg. Co.

Flexible Tie-Downs for Railroad Lading,[3] by *J. W. Sherrick*, Lord Mfg. Co.

THURSDAY, NOVEMBER 30 9:30 a.m.

Jointly With Maintenance

See Maintenance 1

SAFETY

SESSIONS

1 MONDAY, NOVEMBER 27 9:30 a.m.

Jointly With Air-Pollution Controls and Human Factors

Panel Discussion: The Mechanical Engineer and the Industrial Hygienist

The Mechanical Engineer in the Chemical Industry,[2] by *H. R. Hoyle*, The Dow Chemical Co.

The Mechanical Engineer in the Steel Industry,[2] *speaker to be announced*

The Mechanical Engineer in a Manufacturing Industry,[2] by *Vincent Castrop*, Gen. Motors Corp.

The Mechanical Engineer and Problems in Air Pollution,[2] by *Raymond Smith*, Philadelphia Dept. of Public Health

2 MONDAY, NOVEMBER 27 2:30 p.m.

Jointly with Production Engineering, Machine Design, and Human Factors

Panel Discussion: Planning Safety Into Machine Tools

Electrical Safety Machine Tools,[2] by *R. W. Totten*, Gen. Motors Inst.

Integrating the Man Into a Productive Machine Set-Up,[2] by *Rudoless Drillis*, New York Univ.

A Production Operator's Viewpoint of Machine-Tool Safety,[2] by *D. R. Bell*, Gen. Motors Corp.

Machine-Tool Builders Approach to Safety,[2] by *J. C. Horth*, Yates American Machine Co.

3 TUESDAY, NOVEMBER 28 9:30 a.m.

Jointly With Mechanical Engineering Department Heads

Panel Discussion: Safety in Mechanical Engineering Education

Safety in the Engineering Curriculum,[2] by *H. J. Loberg*, Cornell Univ.

Safety Considerations in the Design of a Mechanical-Engineering Laboratory,[2] by *Steve Cenko*, General Motors Inst.

Safety in Metal-Cutting Laboratories,[2] by *K. J. Trigger*, Univ. of Illinois

Safe Use of Volatile Fuels in the Mechanical-Engineering Laboratories,[2] *speaker to be announced*

4 TUESDAY, NOVEMBER 28 2:30 p.m.

Jointly With Nuclear Engineering

Panel Discussion: Radiation Protection for the Mechanical Engineer

Power Boilers and Reactor Manufacturing,[2] by *Harry Johns*, Combustion Engrg., Inc.

Living With Radiation at a Nuclear Research Reactor,[2] by *E. S. Kenney*, Pennsylvania State Univ.

Petroleum Research and Operation,[2] by *M. S. Donovan*, Texaco, Inc.

Aeronautical,[2] by *R. G. Barrett*, Curtiss-Wright Corp.

SOLAR ENERGY

SESSIONS

1 THURSDAY, NOVEMBER 30 9:30 a.m.

Closed-Cycle, Space-Solar-Power-Plant Weight Optimization, by *P. J. Berenson*, Arthur D. Little, Inc. (Paper No. 61—WA-159)

Radiation Characteristics in the Optimization of Solar Heat-Power Conversion Systems, by *D. K. Edwards* and *K. E. Nelson*, Univ. of California (Paper No. 61—WA-158)

Solar Energy Progress Report for 1961,[2] by *J. I. Yellott*, John Yellott Engrg. Associates, Inc.

2 THURSDAY, NOVEMBER 30 2:30 p.m.

A Progress Report on Evaluation of Solar Sea-Water Stills,[2] by *J. W. Bloemer* and *J. A. Eibling*, Battelle Memorial Inst.

Internally Focusing Solar Power Systems,[2] by *Theodor Finkelstein* and *J. A. Eibling*, Battelle Memorial Inst.

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[1] Not presented orally.

[3] Paper not available—see box on page 112.

[2] Not to be printed.

[3] Paper not available—see box on page 112.

[2] Not to be printed.

UNDERWATER TECHNOLOGY SESSIONS

1 WEDNESDAY, NOVEMBER 29 9:30 a.m.

Underwater Technology in Advanced Weapons Systems Design,[3] by *W. F. Raborn*, Dept. of the Navy

On Engineering of Underwater Vehicles, by *H. E. Sheets*, Gen. Dynamics Corp. (Paper No. 61—WA-95)

Current Research in Oceanography,[3] by *P. M. Fye*, Woods Hole Oceanographic Institution

2 WEDNESDAY, NOVEMBER 29 2:30 p.m.

Jointly With American Rocket Society, Inc.

A Matrix Method of Analysis of Structure-Fluid Interaction Problems,[3] by *L. H. Chen*, Gen. Dynamics Corp.

Feasibility of Pressure Hulls for Ultra-Deep Running Submarines, by *Edward Wenk, Jr.*, The White House (Paper No. 61—WA-187)

Experiments With Swimming Fish and Dolphins, by *M. W. Rosen*, U. S. Naval Ordnance Test Station (Paper No. 61—WA-203)

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[3] Paper not available—see box on page 112.

WOMEN'S PROGRAM

▶SUNDAY, NOVEMBER 26

2:00 p.m.	Registration
4:00 p.m.	"Early-Bird" Party

▶MONDAY, NOVEMBER 27

8:00 a.m.	Registration
8:30 a.m.	Coffee Hour
12:15 p.m.	President's Luncheon
2:00 p.m.	Tour of United Engineering Center
2:00 p.m.	Auxiliary Workshop
8:00 p.m.	"Norwegian Night"—Social Get-together

▶TUESDAY, NOVEMBER 28

8:00 a.m.	Registration
8:30 a.m.	Coffee Hour
10:00 a.m.	Annual Business Meeting of the Auxiliary
2:00 p.m.	Tour of United Engineering Center
4:00 p.m.	Tea Dance
6:45 p.m.	Night Club Tour
8:30 p.m.	Theatre Party—"Carnival"

▶WEDNESDAY, NOVEMBER 29

8:00 a.m.	Registration
8:30 a.m.	Coffee Hour
8:30 a.m.	National Board Breakfast followed by National Board Meeting
9:30 a.m.	Program on Cosmetics
12:00 noon	Annual Luncheon and Fashion Show
2:00 p.m.	Tour of United Engineering Center
6:00 p.m.	Social Hour
7:00 p.m.	Banquet
10:00 p.m.	Dance

▶THURSDAY, NOVEMBER 30

8:00 a.m.	Registration
8:30 a.m.	Coffee Hour
10:30 a.m.	Tour of Seagram Building
11:30 a.m.	Luncheon in The Brasserie
2:00 p.m.	Tour of United Engineering Center

Automation and Its Potential for the Textile Industry Keynote of ASME Textile Engineering Conference

Automation and its potential for the textile industry will be the subject of the ASME Textile Division Conference to be held at the Little Theatre, Kresge Auditorium, M.I.T., November 1–2. Lowell Technological Institute and the Textile Division of M.I.T.'s Mechanical-Engineering Department are cosponsors of the Conference. The program formulated under the chairmanship of Dr. K. R. Fox, Mem. ASME, of Fabric Research Laboratories, Inc., consists of three technical sessions and arrangements for plant and laboratory visits.

The first session will be devoted to engineering aspects of process control emphasizing problems in the dynamics of processing and in material-process interactions. The second session is entitled applications of automation to textile operations and will present the approach of the spinner and weaver, the cloth finisher, and the machinery manufacturer toward automation in textile production. Techniques useful in an automated textile organization will be considered in the third session, with papers on computer applications, control techniques, and operations research. A general lecture will be devoted to selection and training of personnel for the automated mill.

▶WEDNESDAY, NOVEMBER 1

Session 1 Engineering Aspects of Process Control 9:30 a.m.

Dynamic Behavior of Textiles During Processing, by *Stanley Backer*, Massachusetts Institute of Technology

Interaction of Fibers and Textile Processes, by *H. M. Morgan*, Fabric Research Labs., Inc., Dedham, Mass.

The Effect on Fiber Properties of Certain Textile Processes, by *Ludwig Rebenfeld*, Textile Res. Inst., Princeton, N. J.

A Controls Engineer Looks at Automation for the Textile Industry, by *J. L. Shearer*, Massachusetts Institute of Technology

Session 2 Application of Automation to Textile Operations 2:00 p.m.

A Study of Textile-Processing Actions in the Manufacture of a Worsted Serge, by *C. J. Monego*, Quartermaster Res. & Engrg. Labs., Natick, Mass.

Continuous Processing of Textiles in the Dyeing and Finishing Operations, by *J. J. McDonald*, Lowell Tech. Inst., Lowell, Mass.

Automation and Textile Machinery, by *W. A. Newell*, Whitin Machine Works, Whitinsville, Mass.

Recent Foreign Developments in Automated Spinning and Preparatory Equipment, by *E. S. Rudnick*, Edward S. Rudnick Representatives, New Bedford, Mass.

▶THURSDAY, NOVEMBER 2

Session 3 Techniques Useful in an Automated Textile Organization 9:30 a.m.

Selection and Training of Personnel for the Automated Textile Mill, by *Alfred Nissen*, Rensselaer Polytechnic Inst., Troy, N. Y.

Production Scheduling by Electronic Computers—A Re-Evaluation, by *Edward Marso*, The William Carter Co., Needham Heights, Mass.

Operations Research in the Textile Industry, by *R. F. Mennell*, Arthur D. Little, Inc., Cambridge, Mass.

Industrial Tours 1:00 p.m.

Group 1:	M.I.T. Textile Division
Group 2:	Lowell Technological Institute, Lowell, Mass.
Group 3:	Fabric Research Laboratories, Inc., Dedham, Mass.
Group 4:	Whitin Machine Works, Whitinsville, Mass.
Group 5:	Crompton & Knowles Corp., Worcester, Mass.

Technical Sessions Will Cover Nine Major Areas at 1962 Nuclear Congress and Atomic Exposition

Operating experience with power reactors topic of all-day general session

Public aspects in the use of nuclear energy, as well as engineering and operational problems within the nuclear industry, will highlight discussions at the technical sessions of the 1962 Nuclear Congress and Atomic Exposition.

This has been announced by Lombard Squires of the E. I. du Pont de Nemours & Co., Inc., General Chairman of the event, which will be held June 4–6, 1962, in the New York Coliseum under sponsorship of the Engineers Joint Council, a federation of 24 engineering and technical societies, with an aggregate membership of 300,000 engineers.

Technical Sessions. Program Committee has selected nine major areas into which the technical sessions will be divided and adopted a definition of the objectives of the Nuclear Congress and Atomic Exposition. Leading engineers and scientists in the nuclear field will be invited to present papers in their particular areas of interest. The technical sessions will be designed particularly to meet the needs of all engineers engaged in the nuclear field and will be divided into the following major areas: Public aspects of nuclear use, problems of advanced reactors, nuclear education for engineers, computational problems in the nuclear industry, application of atomic physics for tests of materials, instrumentation, testing methods, radiochemical separation, fuel cycling, and nuclear safety.

Sessions in these areas will be held concurrently, June 5 and 6. June 4 will be

(*Continued on page 122*)

S. P. Kezios, Illinois Institute of Technology

K. H. Platt, The Institution of Mechanical Engineers, London, England

B. H. Spurlock, University of Colorado

At the International HEAT TRANSFER Conference,

Present. Belgium • Canada • England • France •

At the International Heat Transfer Conference, held at the University of Colorado, Boulder, Colo., Aug. 28–Sept. 1, 1961, 800 engineers of 10 nations gathered to exchange information on latest developments in the calculation of the movement of heat. It was an outstanding example of the co-operation between engineering societies, not only in our country, but throughout the world. The conference was sponsored by The American Society of Mechanical Engineers, American Institute of Chemical Engineers, The Institute of Mechanical Engineers (England), The Institution of Chemical Engineers (England), The National Science Foundation, and the Office of Naval Research; with the participation of the American Chemical Society, The American Nuclear Society, American Rocket Society, American Society of Heating, Refrigerating, and Air-Conditioning Engineers, The Chemical Institute of Canada, The Engineering Institute of Canada, Institute of the Aerospace Sciences, Society of Automotive Engineers, University of Colorado; and the co-operation of the Rocky Mountain Sections, ASME and AIChE.

The word from Boulder: There were more than 100 technical papers—highly technical, most of them—and they were presented by the "rapporteur" method, a procedure in which a rapporteur delivers a summary of the papers for each session (taking 20 minutes for this presentation) and then the session is thrown open for discussion. All participants are expected to have read the papers before the meeting, and come prepared to profit from the discussion.

University in the Mountains. There could hardly have been a better site for an August conference. Boulder is 27 miles northwest of Denver, a short drive from the 14,000-ft peaks of the Continental Divide. It is within walking distance of the foothills of the Rocky Mountains. The University, which was established in 1876, the year Colorado became a state, offered many facilities of interest to the visiting heat-transfer engineers, among them a cryogenics laboratory. The organization of the Conference was good. The weather? Superb. The temperature averaged around 65: And it didn't snow until the day everybody was leaving.

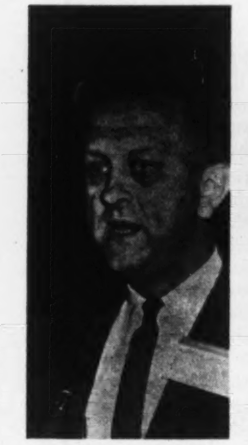
An "International Lounge" was set up in the University Memorial Center, at which all conferees were welcome to enjoy an atmosphere of congeniality and friendship. The prospectus contained a sentence which illustrated the international character of the Conference: "The official language of the Conference is English."

A feature of the Conference was the Calvin Rice Lecture, the fifteenth of the series since the first one in 1934. The Lecture is named to honor the man who served ASME as Secretary from 1906 to 1934, and to further his ideals of increasing understanding between engineers of various countries. The Lecturer was Prof. O. A. Saunders, City and Guilds College, Imperial College of Science and Technology, London, England.

Professor Saunders gave direction to the Conference with his theme that the heat-transfer engineer must not lose sight of the practical aspects of his research. The striving for excessive accuracy in research may be misplaced effort unless the accuracy of any foreseeable application justifies it. He called for practicality in heat-transfer research.

"In recent years," he said, "heat-transfer research has led to substantial practical results in the design of new appliances, such as nuclear power plant and missiles, but has yielded relatively little improvement in conventional plant such as boilers, condensers, heaters, and coolers. A basic reason for this is that designers of new appliances are forced to make greater use of fundamental data and basic methods because they have no established practice to guide them. It is thus more likely that they will consider novel ideas and features.

"There is, however, a large return for even small improvements in conventional heat-transfer appliances, because of their widespread use and expensive nature. It must be remembered that the ultimate criterion is cost, and it is of little value to improve heat transfer by methods which involve increased costs of materials,



W. M. Rohsenow, M.I.T., Chairman of the ASME Heat Transfer Division

E. R. G. Eckert, University of Minnesota

E. H. W. Schmidt, Technische Hochschule Munchen, Munchen, Germany

T. F. Irvine, Jr., State University of New York

H. C. Hottel, Massachusetts Institute of Technology

• Hungary • Italy • Japan • Sweden • Switzerland • U. S. A. at Boulder, Colo.

manufacturing methods, or fans for higher pressure drops, which outweigh the savings.

"Perhaps the general conclusion is that the establishing of more accurate heat transfer under controlled conditions by theoretical and laboratory experimental work, although of value in systematizing design techniques, does not necessarily lead to better design."

You Can Buy the Papers. The literature produced by this Conference is available in five paper-bound volumes, sold by the ASME Order Department, United Engineering Center, 345 East 47th Street, New York 17, N. Y. The five volumes are sold as a unit: The price, $22. About 1000 copies have already been sold, before and during the Conference.

On January 8, 1962, discussion of these papers will be continued in London, England, at the Central Hall Lecture Theatre, Westminster. Later in 1962, publication of these papers will be enlarged to include all the discussion that generated in Boulder, and that which is developing in London.

We have here what we hope will become a traditional event. In 1951, the first such international Heat Transfer Conference was held in London, called "General Discussion of Heat Transfer." Now, ten years later, we have another one, an authoritative discussion of all heat-transfer developments since that time, bringing engineers up to date on the state of the art. The basic plan has been to hold the next such Conference in 1971, but discussions at Boulder lead to the belief that it may take place at a much shorter interval. The discipline is increasing in breadth and depth so fast as to make an earlier International Conference a probable necessity.

Besides the Calvin Rice Lecture, there were three other formal lectures. They were:

"Research During the Last Decade on Forced Convection Heat Transfer," by Prof. E. R. G. Eckert of the University of Minnesota;

"Problems in Radioactive Transport," by Prof. H. C. Hottel of the Massachusetts Institute of Technology;

"Heat Transfer by Natural Convection," by Prof. Ernst Schmidt of the Technische Hochschule in Munich, Germany.

O. A. Saunders, Imperial College of Science and Technology, London, England, **(left)**, and W. H. Byrne, President, ASME. Professor Saunders, Calvin Rice Lecturer, became a Life Member of ASME.

Nuclear Congress (*Continued from page 119*)

devoted to an all-day General Session at which a number of papers will discuss "Operating Experience With Power Reactors."

Nuclear Congress Defines Objective. The Program Committee adopted the following definition of the objective of the Nuclear Congress and Atomic Exposition:

"The 1962 Nuclear Congress and Atomic Exposition will provide professional engineers and management with an up-to-date review of engineering problems in the nuclear field. It will provide state of the art presentations and authoritative reviews by well-qualified and active participants in the application of engineering to nuclear problems. Major attention will be focused on the status of civilian power reactions on the impact on the public of nuclear reactor and radiochemical-processing plants and to the major issues now facing the nuclear industry."

The Nuclear Congress was established in 1955 to provide a cross-fertilization of ideas among engineers and scientists and the nuclear industry. It met annually in conjunction with the Atomic Exposition, the most recent joint event being held in April, 1960. The Congress Manager for the 1962 event is Newell Appleton of the American Institute of Mining, Metallurgical and Petroleum Engineers.

Earlier this year, EJC announced that the next Nuclear Congress and Atomic Exposition will be held in June, 1962, and that this will formally establish the scientific gathering as a biennial joint event for all engineers, scientists, and technicians in the nuclear field.

The Reber-Friel Company of Philadelphia, which has managed all the previous Atomic Expositions will be in charge of the exhibits for the 1962 event. Floor plans and other exhibit information are now being readied for distribution to the nuclear industry. Firms wishing to receive these materials may write the Reber-Friel Company at 117 South 17th Street, Philadelphia 3, Pa.

Member of the Program Committee of the 1962 Nuclear Congress and Atomic Expositions representing ASME is Fitzgerald D. Acker.

Engineering Index Bigger Than Ever

The Engineering Index annotates and indexes selectively on the basis of engineering significance, the available current technical periodicals received by, and permanently housed in, the Engineering Societies Library. Included are the regular professional journals, trade journals, publications of engineering societies, scientific and technical associations, universities, laboratories and research institutions, government departments and agencies, and industrial organizations. Papers of conferences and symposiums, separate and nonserial publications of various kinds, and selected books also are covered. Patents are excluded. In all, more than 3300 publications are received. These are printed in 22 languages and come from 42 countries.

The Engineering Index service is divided into 249 "Field of Interest" divisions. It is issued in two forms: On 3 × 5 in. library cards mailed weekly to all subscribers, and in a bound volume, 7 × 10 in. which contains the information distributed by the card index service for a full calendar year.

The 1960 bound volume was ready for distribution July 1, 1961. It contains 1759 pages; including a list of 14 pages of publications reviewed; 104 pages listing authors, and 1628 pages of subject index which contain over 34,000 annotations. The bound volume of The Engineering Index is now available in Public Libraries of 91 cities in the United States, and also in 58 libraries of cities throughout the world. It is in 245 libraries of colleges in the United States, and 125 libraries of colleges in other countries.

It is obvious, therefore, that the dissemination of technical information is made available to a vast number of engineers and technologists around the world. The Engineering Index makes it possible for the 350,000 members of all the organizations who occupy the new United Engineering Center to receive annotations of the technical literature permanently housed in the Engineering Societies Library, located at 345 East 47th Street, New York, 17, N. Y. The total number of people employed by the Engineering Societies Library is 24, plus another 22 on part-time basis; whereas The Engineering Index employs 30 people full time and another ten part time. Thus The Engineering Index staff expands the services rendered by the Engineering Societies Library to the engineering profession, to industry, and to government—national, state, and local. Likewise, The Engineering Index makes it practical to store annually for several years (in a comparatively small space) the record of development of each of the 249 "Field of Interest" divisions of Engineering.

The price of the 1960 Volume of The Engineering Index is $75 postpaid. This volume is comprehensive, covering all applications of engineering methods and concepts to industry, agriculture, mining—the entire economy. No other abstracting service covers world-wide technological literature as extensively. Libraries—public and special—industrial firms, trade associations, governmental bureaus, schools and universities, and many individual engineers and technological specialists subscribe to keep informed, or for reference and bibliographical help on specific projects.

Following is a tabulation of the number of foreign publications, and the countries from which they emanate: England, 218; Germany, 89; France, 58; USSR, 41; Canada, 34; Japan, 26; Australia, 23; Belgium, 23; Sweden, 23; Italy, 18; Switzerland, 18; India, 17; The Netherlands, 14; Austria, 12; Argentina, 11; Poland, 11; South Africa, 11; Denmark, 9; Spain 7; Czechoslovakia, 5; Mexico, 4; Peru, 4; China, 3; Brazil, Finland, New Zealand, Norway, Portugal, Roumania, Scotland, The Philippines, Venezuela, Yugoslavia, Greece, two each; and Chile, Hungary, Iceland, Israel, Pakistan, Turkey, Uruguay, and Wales, one each.

Catalogue free on request, The Engineering Index, Inc., United Engineering Center, 345 East 47th Street, New York 17, N. Y

Our New United Engineering Center and Money

Work on the First Edition of the special bound book of subscribers will start immediately. It will include the names of those who have subscribed to the ASME quota. An asterisk will indicate those whose pledges have been paid in full, as of November 15. This date is the latest which will permit us to have available a record for examination by our members during the Winter Annual Meeting. The listings will be by Section, and a member's name will be shown under that Section to which his gift was credited.

A final edition of the Subscribers' book will be completed at some later date, when all pledges are in and paid. These records will not be completed until some

(*Continued on page 124*)

Prager and Reissner Give General Lectures at West Coast Applied Mechanics Conference

The 1961 West Coast Conference of Applied Mechanics was held at the University of Washington, Seattle, Wash., Aug. 28–30, 1961. The conference, sponsored jointly by the Applied Mechanics Division of The American Society of Mechanical Engineers and the Engineering Mechanics Division of the American Society of Civil Engineers, attracted 195 registrants from all regions of the United States. Attendees were enthusiastic both about the program and the location of the meeting. The weather was excellent and the scenery beautiful.

Prof. William Prager, Mem. ASME, of Brown University opened the conference with his general lecture, "On the Construction of Constitutive Equations," in which he discussed the constitutive equations for the composite elastic, perfectly plastic solid, and emphasized the value of Jaumann's definition of stress rate. Prof. Eric Reissner, Mem. ASME, of M.I.T., presented the other general lecture, "Variational Considerations of Shell Theory," in which he gave the general canonical formulation for a shell, and showed how a boundary-layer approach can be used to combine the interior solution with that for the edge effects.

Thirty ASME technical papers (listed in the July, 1961, issue of Mechanical Engineering, pp. 94, 95) and four ASCE technical papers were presented in sessions on fluid dynamics, dynamics of solids, vibrations of solids, elastodynamics, plasticity, dynamic plasticity, cracks, shells, and beams and plates. Boeing Airplane Company provided an inspection trip through their structural test and wind-tunnel facilities following a dinner at the plant for the visitors.

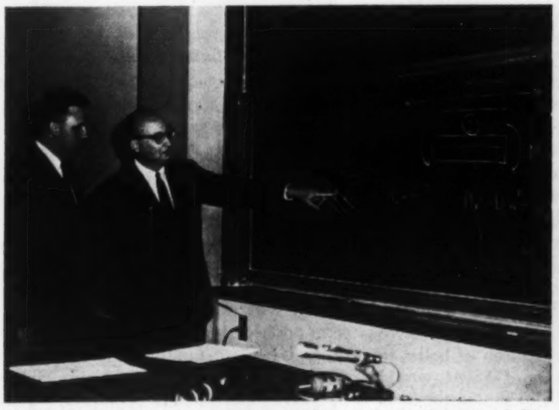
It was announced at the luncheon meeting that there will be no West Coast Applied Mechanics Conference next year because the U. S. National Congress on Applied Mechanics will be held in Berkeley, Calif., in June, 1962. The location for the 1963 Conference has not yet been established.

The present members of the West Coast Committee of the ASME Applied Mechanics Division are: Prof. George A. Zizicas, Mem. ASME, of the University of California at Los Angeles, Chairman; Prof. Julius Miklowitz, Mem. ASME, of the California Institute of Technology, Secretary; William A. Gross, Mem. ASME, of the International Business Machines Research Laboratory, San Jose; James G. Berry, Mem. ASME of Space Technology Laboratories, Los

At the Applied Mechanics Conference in Chicago

Eager Applied Mechanics Meeting attendees at the 1961 Conference, flock to preprint counter to buy technical papers. The conference, held June 14 to 16, was reported in the August, 1961, issue of MECHANICAL ENGINEERING. An availability list of papers was included.

Speaker and chairman at general lecture include, **left to right:** Eugene Sevin, vice-chairman; Dave Fultz, lecturer; and L. H. Donnell, chairman. Professor Fultz spoke on fluid mechanics experiments for geophysical purposes.



At blackboard during June meeting session on elastic plates are, **left to right:** M. W. Johnson, vice-chairman of session, and Eric Reissner, one of the speakers.

Enjoying chat are, **left to right:** D. E. Taylor; A. M. Wahl, chairman, executive committee, Applied Mechanics Division; and P. G. Hodge, Jr., chairman, local committee.

At the West Coast Applied Mechanics Conference

At ASME West Coast Applied Mechanics Conference. **Left to right,** front row: W. A. Gross, incoming division secretary, West Coast Committee; W. Prager, general lecturer; E. Reissner, general lecturer; J. Miklowitz, program chairman. Back row: Emmett Day, local arrangements; T. H. Lin, incoming secretary, ASCE; K. S. Pister, incoming chairman, ASCE; G. A. Zizicas, chairman; P. M. Naghdi; B. J. Hartz, chairman, ASCE West Coast Committee.

Angeles; Prof. Paul M. Naghdi, Mem. ASME, of the University of California, Berkeley.

Availability List—Applied Mechanics West Coast Conference

The papers in this list are available in separate copy form until June 1, 1962. Please order only by paper number; otherwise the order will be returned. You can save the postage and handling charges by including your check or money order made payable to ASME with your order and sending both to the ASME Order Department, United Engineering Center, 345 East 47th Street, New York 17, N. Y. Papers are priced at 50 cents each to members; $1 to nonmembers. Payment also may be made by free coupons distributed annually to members, or coupons which may be purchased from the Society. Coupons, in lots of ten, are $4 to members; $8 to nonmembers.

61—APMW-1 An Addition to the Theory of Whirling, by T. R. Kane

61—APMW-2 Natural Frequencies of Vibration of Fixed-Fixed Sandwich Beams, by M. E. Raville, En-Shiuh Ueng, and Ming-Min Lei

61—APMW-3 Mixing of Compressible Fluids, by E. D. Kennedy

61—APMW-4 On the Parametric Excitation of Pendulum-Type Vibration Absorber, by E. Sevin

61—APMW-5 The Hump Deformation Preceding a Moving Load on a Layer of Soft Material, by G. R. Abrahamson and J. N. Goodier

61—APMW-6 Permanent Periodic Surface Deformations Due to a Traveling Jet, by G. R. Abrahamson

61—APMW-7 Bowing of Cryogenic Pipelines, by W. G. Flieder, J. C. Loria, and W. J. Smith

61—APMW-8 Elastic-Plastic Design of Rectangular Pressure Tubing, by R. D. Gauthier and E. E. Weibel

61—APMW-9 Dynamics of Nonholonomic Systems, by T. R. Kane

61—APMW-10 Dynamic Membrane Stresses in a Circular Elastic Shell, by R. G. Payton

61—APMW-11 An Approximate Analytical Solution for the Stepped Bearing, by C. F. Kettleborough

61—APMW-12 Linearized Transonic Flow About Slender Bodies at Zero Angle of Attack, by P. F. Maeder and H. U. Thommen

61—APMW-13 A Note on a New Stability Method for the Linear Modes of Nonlinear Two-Degree-of-Freedom Systems, by J. Porter and C. P. Atkinson

61—APMW-14 Shear Deformation in Beams on Elastic Foundations, by F. Essenburg

61—APMW-15 Bending of Plates on an Elastic Foundation, by K. S. Pister and R. A. Westmann

61—APMW-16A Analysis for Calculating Lateral Vibration Characteristics of Rotating Systems With Any Number of Flexible Supports, Part 1—The Method of Analysis, by E. C. Koenig

61—APMW-16B Analysis for Calculating Lateral Vibration Characteristics of Rotating Systems With Any Number of Flexible Supports
Part 2—Application of the Method of Analysis, by T. G. Guenther and D. C. Lovejoy

61—APMW-17 Dynamical Stress Concentration in an Elastic Plate, by Yih-Hsing Pao

1—APMW-18 On a Class of Oscillations in the Finite-Deformation Theory of Elasticity, by J. K. Knowles

—APMW-19 Nonsymmetric Deformation of Dome-Shaped Shells of Revolution, by C. R. Steele

61—APMW-20 Transient Response of a Dynamic System Under Random Excitation, by T. K. Caughey and H. J. Stumpf

61—APMW-21 On the Application of Variational Methods to Initial Value Problems in Dynamics, by W. Stuiver

61—APMW-22 Dynamic Stability of a Pendulous Missile Suspension System, by V. Chobotov

61—APMW-23 Green's Functions for Axially Symmetric Elastic Waves in Unbounded Inhomogeneous Media Having Constant Velocity Gradients, by J. F. Hook

61—APMW-24 On the Buckling of Truncated Conical Shells in Torsion, by P. Seide

61—APMW-25 Wave Propagation in an Elastic Beam or Plate on an Elastic Foundation, by J. R. Lloyd and J. Miklowitz

61—APMW-26 Transient Thermoelastic Problem for an Infinite Medium With a Spherical Cavity Exhibiting Temperature-Dependent Properties, by J. Nowinski

61—APMW-27 The Stress Field Produced by Localized Plastic Slip at a Free Surface, by T. H. Lin and T. K. Tung

61—APMW-28 Dynamic Stresses Created by a Moving Crack, by B. R. Baker

1—APMW-29 Crack-Tip, Stress-Intensity Factors for Plane Extension and Plate Bending Problems, by G. C. Sih, P. C. Paris, and F. Erdogan

61—APMW-30 A Method for Analyzing Axisymmetric Plates With Complicating Conditions, by J. E. Brock

UEC *(Continued from page 122)*

time in 1963, the terminal date of some of the three-year subscriptions received during the past year.

ASME is now at home in the United Engineering Center. The Executive Committee of the Council has used the new Council room in their new quarters. At the first opportunity, you should pay us a visit; it is just a step from Grand Central Terminal. When you do so, remember that this project has been made possible by a dedicated minority of our profession. These engineers give their support without fanfare, as becomes a true professional engineer. Also many gave not one but two or three times as the need developed.

Unfortunately, the profession does not own the new Center free and clear; outside financing has been necessary. The bound book of subscribers now shows that, from a membership of 48,000, just over 20,500 gifts have been received. There are, however, at least 27,500 ASME members, not shown, who have not given to this building, a project that belongs to and serves the entire profession. Also the UET records show that many have supported this Engineering Center at a level far below that commensurate for ASME. From these two groups a concrete expression of belief in the aims and objectives of ASME would be most welcome at this time, in the form of a substantial year-end subscription.

There is also another problem in this area of finances. Approximately $725,000 has been paid in cash by ASME members to date, cash that can buy bricks and mortar and all the trim that make a building usable. There are outstanding $107,000 in unpaid ASME pledges, almost $20,000 of which is overdue and may be in default. We must reduce both of these figures as rapidly as feasible. It costs money, which can be reflected in increased rent, to hire capital whether it be obtained as short term notes or long term mortgages. All of us with outstanding unpaid pledges can help reduce the cost of hiring money by paying our pledges promptly. Thus we will bring closer the day of complete ownership of the UEC by the profession.

Conducted for
the National Junior
Committee

STEWART H. ROSS[1]

JUNIOR FORUM

Subjects: Education, Civic Affairs

"If a little knowledge is dangerous, where is the man who has so much as to be out of danger?"—Thomas Henry Huxley.

Education. Education—what kind; for how long; to serve what purpose, if for practical purpose at all; for whom—is the popular after-dinner-speech topic of our decade. The speakers themselves cover a broad range, from the nonpartisan-informed to the political-hysterical. We have iconoclasts and pork-barrelers, speakers who make good sense and those who do not.

L. M. White, director of research of United States Rubber Company, gave a talk[2] on the subject this past summer. What follows—certain of Dr. White's remarks of particular interest to the new engineer—illustrates the views that must be aired before the public, and made understandable to the public, if the growth of our educational system is to parallel the burgeoning needs of our society.

. . . "When the young technical graduate comes to us, we try to give him an environment in which he can continue his education. He learns mainly by working with senior technical men on the job. He has the opportunity of meeting and talking with eminent university scientists who serve as our consultants. He may be sent to a college for special advanced courses.

"Gradually the young scientist takes on greater responsibilities.

"Although we offer him a quiet atmosphere much like a university professor's laboratory, he does not remain secluded for long in this ivory tower. The phone on his desk and the reports in the morning mail keep him just an arm's length away from our factories and from the problems of our customers.

. . . "Our technical men may be promoted either to administrative positions or research positions of higher responsibilities. Thus there are opportunities for all personality types—the outgoing and the introspective, the man who excels at solving organization problems, and the man who prefers the challenges of the laboratory.

. . . "Because industry is so highly competitive, employees must constantly be shifting the focus of their efforts.

"Versatility thus becomes a trait highly desired.

. . . "What kind of man, then, can best fill the technical needs in our country?

"We need a man who, first and foremost, can reason and think.

"We need a man who can move easily from one area of interest to another.

"We need a man who will be inspired and stimulated by seemingly impossible problems.

"We need a man who can communicate ideas, and who can speak and write intelligently and simply enough for others to comprehend, including less educated persons than himself.

"We need a man who understands basic economics and appreciates the workings of the profit system, and knows what is practical, what will have value in the marketplace.

"We need a man who has his specialized training backed up with broad knowledge.

"We need a man who can be productive in nonscientific activities where facts are scarce . . . and the difference between right and wrong obscure.

"We need a man who questions whether he is doing the right thing, for his company, for the company's customers, for his country, and for humanity itself.

"What we are looking for is a creative and reasoning man, a versatile man, a man with ingenuity and imagination, with the will to work, and with a conscience."

Civic Affairs. The engineer in the role of a voluntary expert-adviser to his community is one generally neglected by inexperienced and experienced engineers alike. But there is a host of compelling reasons why the young engineer, in particular, should look around him for such opportunities to serve.

- He can increase the stature of his profession when he exhibits the skills of the trained engineer.
- He can gain valuable experience in dealing with people.
- He can help his community, make it a better place in which to live.
- He is challenged by the diversity of technical problems that come his way, experience not necessarily obtainable on-the-job.

Specifically, how can the wide-awake engineer make a real contribution to his community? Let us look at how James L. O'Neill, Chairman of the ASME Region II, Civic Affairs Committee, has tackled this job.

1 He is Chairman of the Mid-Hudson Science Advisory Council. This council works with 55 high schools in five counties, arranging seminars and panel discussions and preparing workshop programs for both students and teachers. It assists at science fairs, arranges plant visits for students, sees to it the schools get surplus tools and supplies from industry.

2 He is Chairman of the Advisory Board for Science Education, Board of Education, Poughkeepsie City School District. This board directs all secondary-school science activities, was instrumental in adding Russian and German to the curriculum, sponsors an annual science fair and a 16-week exceptional-student science seminar.

Further, because of the high fire loss in Poughkeepsie, N. Y., Mr. O'Neill suggested to the City Manager that regular inspections of all types of property be made, inspection reports be left with the owners indicating fire hazards, and that 30 days be given to eliminate the fire hazards. This suggestion later became a City Ordinance, and Poughkeepsie's fire loss has since dropped considerably.

Is your community concerned over a growing air-pollution problem, planning enlarged sewage-disposal facilities, building a new incinerator, lacking sufficient municipal parking, or satisfactory urban zoning regulations? Or are you personally convinced that fluoridation of your city's water supply is necessary? As a mechanical engineer, you are eminently qualified to give expert advice to your community in these affairs. Do not lose the opportunity to do so.

NJC Session at the 1961 Winter Annual

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[1] Proposals writer, Product Information Operation, General Electric Company, Pittsfield, Mass. Assoc. Mem. ASME.

[2] "Education for the Technological Age," presented before the National Science Foundation Institute for High-School Teachers at the University of Rochester, July 13, 1961.

Meeting. "Patents and Professional Development" will be the topic of this year's National Junior Committee-sponsored Junior Session at the Annual Meeting. The session, at 8:00 p.m. on November 28, is aimed at acquainting participants with the U. S. patent system and impressing them with the importance of patents to the engineer's professional development.

Speakers will be John F. Hanafin, Domestic Patents Operations Manager, IBM Corporation, New York, N. Y.; Herbert S. White, Engineering Library Manager, IBM Corporation, Kingston, N. Y.; and Louis E. Marn, Manager, Patent and Licensing Department, The Lummus Company, New York, N. Y.

1600 Attend 12 ASME Regional Student Conferences

During April and May of this year some 1600 Student Members of The American Society of Mechanical Engineers journeyed to, or were hosts at, 12 Regional Conferences held in Rhode Island, New York, District of Columbia, Georgia, Ohio, Michigan, Illinois, Oklahoma, Colorado, Washington, Arizona, and Texas.

The large attendance attests to the importance placed on these meetings: Primarily because this is the best way for the Society's youngest members to learn, in a sense, how the national meetings of the Society are conducted and because the students have an opportunity to see for themselves the advantages to be derived from professional society participation. Their major role is emphasized as they present their papers in technical sessions, the inspection trips they take, arranged by local industry, to manufacturing and research establishments, and by and large their association with fellow students, professors, and leaders in the engineering profession who address their banquets and luncheons.

1961 ASME Regional Student Conference Reports

Region I—Brown University, Providence, R. I., April 21–22, 1961

Attendance: 170
Papers Presented: 13

Prize	Recipient	Title of Paper	College
First	J. J. Marino	Considerations for the Design of an Ammonia-Phosphoric Acid Reactor	University of Connecticut
Second	W. J. McCrea	Reaction Jet Servomotor	Massachusetts Institute of Technology
Third	D. J. Mraz	Aluminum Dispersion Strengthened Alloys	University of Massachusetts
Fourth	G. R. Audette	Continuous Strip Casting of Aluminum	University of Vermont
Old Guard	G. A. Spiratos	The Determination of Velocity Profiles in Low-Velocity Viscous Liquids	University of Rhode Island

Region II—The Cooper Union, Cooper Square, New York, N. Y., April 29, 1961

Attendance: 77
Papers Presented: 5

Prize	Recipient	Title of Paper	College
First	James Quintiere	Elementary Mechanics of Space Flight	Newark College of Engineering
Second	W. C. Zegel	A Simple Device to Demonstrate Pipe-Flow Phenomena	Stevens Institute of Technology
Third	Joyce A. Myron	A Problem in Heat Dissipation	New York University
Fourth	E. L. Molishever	On the General Formulation of Thermomechanical Systems by the Methods of Linear Irreversible Thermodynamics	The Cooper Union
Old Guard	Martin Sobel	Civic Responsibilities of the Engineer	Rutgers University

Region III—Howard University, Washington, D. C., April 21–22, 1961

Attendance: 130
Papers Presented: 11

Prize	Recipient	Title of Paper	College
First	F. J. Wiele	Engineering Assistance to Speech Therapy	Villanova University
Second	J. R. Crouse	Circular Records	Pennsylvania State University
Third	Sudhir Savkar	The Rotary-Vane Engine	The Catholic University of America
Fourth	J. E. Halbing, Jr.	Spiraloid	Lafayette College
Old Guard	J. H. Somerset, Jr.	Pneumatic Control	Drexel Institute of Technology

Region IV—Georgia Institute of Technology, Atlanta, Ga., April 14–15, 1961

Attendance: 170
Papers Presented: 13

Prize	Recipient	Title of Paper	College
First	R. J. French, Jr.	Nuclear Rocket Propulsion	Georgia Institute of Technology
Second	B. C. Collier	Thermoelectric-Generation Methods	University of Mississippi
Third	A. G. Smith	Saline Water Conversion	Virginia Polytechnic Institute
Fourth	C. D. Guess	The Feasibility of the Heat Pump for Automobiles	Mississippi State University
Old Guard	B. H. Redfearn	The Demand Air Regulator	University of South Carolina

Region V—University of Toledo, Toledo, Ohio, April 14–15, 1961

Attendance: 148
Papers Presented: 12

Prize	Recipient	Title of Paper	College
First	N. A. Herman	Indirect Methods of Determining the Effects of Flow Non-uniformities on Local Skin Friction	Ohio State University
Second	Carole S. Bennett	To Be an Engineer	Ohio Northern University
Third	K. F. Welsh, Jr.	Nontechnical Aspects of Engineering	The Ohio University
Fourth	E. V. Elslander	Design of a Machine to Punch, Notch, and Saw Window Frames of Ford Falcon	Wayne State University
Old Guard	Frank Sefidvash	Digital Computer Analysis of Rosette Strain Gages	West Virginia University

Regions VI and VII—Northern Tier—Michigan College of Mining & Technology, Houghton, Mich., May 5–6, 1961

Attendance: 108
Papers Presented: 8

Prize	Recipient	Title of Paper	College
First	R. P. Schuchmann	Elements of a Simple Parametric Amplification System	Iowa State University

Prize	Recipent	Title of Paper	College
Second	W. H. Rauer	Why Air Bearings?	North Dakota State University
Third	J. A. Stoddard	Nuclear Aircraft Shielding	South Dakota State College
Fourth	I. R. Thompson	Lock-Up Mechanism	Northwestern University
Old Guard	Benjamin Braunberger	The Stirling Cycle	University of North Dakota

Regions VI and VII—Southern Tier, University of Illinois, Urbana, Ill., April 14–15, 1961

Attendance: 80

Papers Presented: 8

Prize	Recipient	Title of Paper	College
First	C. R. Buschman	A Nuclear Method for Gaging Gas Density	University of Kentucky
Second	J. E. Haggard	Special Material Problems in Nuclear Reactors	University of Notre Dame
Third	L. A. Roberts	Plasma Physics	Missouri School of M&M
Fourth	J. S. Culp	Proposed Ion Propulsion System	Bradley University
Old Guard	Milan Blaho	Design Problems in Speedometers	University of Illinois

Regions VII and X(NOAK) University of Oklahoma, Norman, Okla., April 17–18, 1961

Attendance: 115

Papers Presented: 12

Prize	Recipient	Title of Paper	College
First	N. F. Luther	Automotive Wheel Lugs—Right or Left-Hand Thread	University of Kansas
Second	M. D. Schuman	The Analytical and Experimental Determination of the Characteristics of Zinc Sulfide in Rocket Nozzles	Kansas State University
Third	J. L. Stafford	Space Vehicle Thermal Environmental Analog	Kansas State University
Fourth	L. W. Oline	Predicting Failure of Brittle Materials Under Biaxial Stress	University of Kansas
Old Guard	J. C. Hale	Ram Induction	University of Arkansas

Region VIII—Rocky Mountain, University of Colorado, Boulder, Colo., April 21–22, 1961

Attendance: 186

Papers Presented: 15

Prize	Recipient	Title of Paper	College
First	B. H. Howell	Alcohol Fuel Tests on an Automotive Engine	University of Wyoming
Second	L. O. Cropp	A Method for Determination of Viscous Drag on Rotating Bodies	University of Colorado
Third	W. W. Smith	The Application of High-Speed Digital Computors to Mechanical Engineering	New Mexico State University
Fourth	P. C. Wergin	Steam and Water Flow Through Venturi Tubes	Colorado State University
Old Guard	Jerry Pontius	A Study of Crankcase Pressure in a Two-Cycle Engine	South Dakota School of M&T

Region IX—Pacific Northwest, University of Washington, Seattle, Wash., May 4–5, 1961

Attendance: 196

Papers Presented: 10

Prize	Recipient	Title of Paper	College
First	R. G. Thompson	Supersonic Nozzle Design by the Method of Characteristics	University of British Columbia
Second	S. A. Rhodes	Research on Solid Damping Torsional Vibration	Washington State University
Third	C. D. Compton	Vehicle Drag	University of Washington
Fourth	R. L. Leonard	Rocket Motor Turbopumps	University of Washington
Old Guard	K. L. Jordan	Research on Solid Damping Flexural Vibration	Washington State University

Region IX—Pacific Southwest, University of Arizona, Tucson, Ariz., April 28–29, 1961

Attendance: 92

Papers Presented: 17

Prize	Recipient	Title of Paper	College
First	D. A. Oliver	Magneto-Gas Dynamic Power Generation	University of Santa Clara
Second	D. J. Collins	Design Considerations for Chemical Absorption Trap and Oil Migration Baffle of a Vacuum System	University of Arizona
Third	B. J. Robinson	Notched Straight Wall Diffusers	Stanford University
Fourth	Dan Forster	Corrosion in Laminar Flow	University of California
Old Guard	C. A. Foulger	Aerodynamic Analysis of Indianapolis Speedway Car	University of Southern California

Region X—Gulf States, University of Texas, Austin, Texas, April 15, 1961

Attendance: 119

Papers Presented: 10

Prize	Recipient	Title of Paper	College
First	M. L. Nicol, 3rd	Explosive Forming	Texas Technological College
Second	D. C. Price	The History and Theory of the Vortex Tube	Southern Methodist University
Third	H. W. Bulbrook	Air Pollution and Motor-Vehicle Exhaust	Rice University
Fourth	W. D. Jobe	Electric Analog Solution of a Pipe Network	A&M College of Texas
Old Guard	M. A. Berenson	Electric Rocket Engines	Tulane University

Other Prizes Presented at the Regional Student Conferences for 1961

1 Two prizes of $25 and $15 were awarded at each Conference to the Student Section having the largest and second largest attendance.

2 Each Conference presents a Man-Mile Trophy to the Student Section who has traveled the greatest number of miles to the Conference. Winners are listed below:

Region	$25	$15	Man-Mile Trophy
	Northeastern University	University of Rhode Island	Norwich University
II	New York University	Pratt Institute	New York University
III	University of Maryland	Union College	Union College
IV	University of Mississippi	University of South Carolina	University of Mississippi
V	University of Dayton	Ohio Northern University	West Virginia University
VI—Northern Tier	South Dakota State College	University of North Dakota	South Dakota State College
VI—Southern Tier	Missouri School of Mines & Metallurgy	University of Kentucky	Missouri School of Mines & Metallurgy
VII and X—NOAK	University of Nebraska	University of Arkansas	University of Nebraska
VIII	Colorado State University	University of Denver	University of New Mexico
IX—Pacific Northwest	Oregon State University	University of Idaho	Oregon State University
IX—Pacific Southwest	University of Utah	Brigham Young University	University of Utah
X—Gulf States	Texas Technological College	University of Southwestern Louisiana	

ASME COMING EVENTS

October 4–6, 1961

ASME Process Industries Conference, Shamrock Hilton Hotel, Houston, Texas

October 5–7, 1961

ASME-AIME Joint Solid Fuels Conference, Dinkler Tutwiler Hotel, Birmingham, Ala.

October 17–18, 1961

ASME Bulk Solid Handling Symposium, Pick Nicollet Hotel, Minneapolis, Minn.

October 17–19, 1961

ASME-ASLE Lubrication Conference, Morrison Hotel, Chicago, Ill.

November 26–December 1, 1961

ASME Winter Annual Meeting, Statler Hilton Hotel, New York, N. Y.

January 24–26, 1962

ASME Second Symposium on Thermophysical Properties, Princeton University, Princeton, N. J.

March 4–8, 1962

ASME Gas Turbine-Process Industries Conference and Products Show, Shamrock Hilton Hotel, Houston, Texas

March 27–29, 1962

American Power Conference, Sherman Hotel, Chicago, Ill.

April 5–6, 1962

ASME-SAM Management Engineering Conference, Statler Hilton Hotel, New York, N. Y.

April 9–13, 1962

ASME Metals Engineering Division—AWS Conference, Sheraton Cleveland Hotel, Cleveland, Ohio

April 10–11, 1962

ASME-AIEE Railroad Conference, King Edward Hotel, Toronto, Canada

April 11–13, 1962

ASME Spring Textile Engineering Conference, N. C. State College, Raleigh, N. C.

April 15–19, 1962

ASME Oil and Gas Power Conference and Exhibit, Shoreham Hotel, Washington, D. C.

April 24–26, 1962

ASME Production Engineering Conference, the Van Curler Hotel, Schenectady, N. Y.

April 30–May 3, 1962

ASME Design Engineering Conference and concurrent Show, Chicago Exposition Center, Chicago, Ill.

May 7–8, 1962

ASME Maintenance and Plant Engineering Conference, Royal Orleans Hotel, New Orleans, La.

May 21–23, 1962

ASME Hydraulic Conference, Bancroft Hotel, Worcester, Mass.

June 4–6, 1962

ASME Lubrication Symposium, Deauville Hotel, Miami Beach, Fla.

June 4–8, 1962

Nuclear Congress (Biennial), New York Coliseum, New York, N. Y.

June 5–7, 1962

ASME Fuels Symposium, Rutgers University, New Brunswick, N. J.

June 10–14, 1962

ASME Summer Annual Meeting, Chateau Frontenac, Quebec, Canada

June 18–21, 1962

Fourth U. S. Congress on Theoretical and Applied Mechanics, University of California, Berkeley, Calif.

June 26–28, 1962

ASME Aviation Conference, University of Maryland, Washington, D. C.

June 27–29, 1962

Joint Automation Control Conference, New York University, New York, N. Y.

August 5–8, 1962

AIChE-ASME Heat Transfer Conference and Exhibit, Shamrock Hilton Hotel, Houston, Texas

September 13–14, 1962

Joint Engineering Management Conference, Roosevelt Hotel, New Orleans, La.

September 23–26, 1962

ASME Petroleum Mechanical Engineering Conference, Sheraton-Dallas Hotel, Dallas, Texas

September 24–26, 1962

AIEE-ASME National Power Conference, Lord Baltimore Hotel, Baltimore, Md.

October 4–5, 1962

ASME-AIME Joint Solid Fuels Conference, Penn-Sheraton Hotel, Pittsburgh, Pa.

October 16–18, 1962

ASME-ASLE Lubrication Conference, Pittsburgh Hilton Hotel, Pittsburgh, Pa.

November 25–30, 1962

ASME Winter Annual Meeting, Statler Hilton Hotel, New York, N. Y.

(*For Meetings of Other Societies, see page 105.*)

Note: Persons wishing to prepare a paper for presentation at ASME National meetings or Division conferences should secure a copy of Manual MS-4, "An ASME Paper," by writing to the ASME Order Department, United Engineering Center, 345 East 47th Street, New York 17, N. Y. Price to nonmembers, 50 cents; to ASME members, free. Also available on request is a "Schedule of Program Planning Dates for Meetings and Publication Deadline Dates." Ask for Form M&P 1315.

OBITUARIES

George Ernest Ackerman (1876–1961?), partner, Holland, Ackerman & Holland, consulting engineers, Chicago, Ill., died recently, according to a notice received by the Society. Mem. ASME, 1944.

Lester Gehman Cattermole (1892–1961), president, Hage Associates, Inc., consulting engineers, Gardner, Mass., died, June 9, 1961. Jun. ASME, 1917; Assoc-Mem. ASME, 1919; Mem. ASME, 1930.

Robert Lyle Chapman (1920–1961), manager, training and Simulation Department, Thompson-Ramo-Wooldridge Corp., Canoga Park, Calif., died, April 23, 1961. Assoc. Mem ASME, 1950.

Clarence Heck Dibble (1902–1961?), systems engineer, Electrical Research Products Division, Western Electric Company, Inc., Los Angeles, Calif., died recently according to a notice received by the Society. Mem. ASME, 1945.

Seibert Fairman (1896–1961), professor Division of Engineering Sciences, Purdue University, West Lafayette, Ind., died, June 22, 1961. Jun. ASME, 1931; Mem. ASME, 1935. Author of the books "Graphic Statics," McGraw-Hill, and "Engineering Mechanics," John Wiley & Sons, Inc.

James Busse Hartman (1910–1961), professor and head, Mechanical Engineering Department, Lehigh University, Bethlehem, Pa., died, May 6, 1961. Mem. ASME, 1942.

Louis Hill Hungate, Jr. (1903–1961), retired from the Installations Representatives Office, Department of the Air Force, Dallas, Texas, died, Feb. 9, 1961. Mem. ASME, 1942.

Robert Crawford Jeffcott (1878–1961), retired president, Calco Chemical Company, American Cyanamid Company, Boothbay Harbor, Me., died, Feb. 22, 1961. Mem. ASME, 1912.

Richard Edward Krueger (1903–1961), supervisory mechanical engineer, U. S. Bureau of Reclamation, Design and Construction Division, Denver Federal Center, Denver, Colo., died, June 14, 1961. Mem. ASME, 1952.

Albert Hurd Lowman (1892–1961), president and treasurer, Phoenix Specialty Manufacturing Company, Inc., Garden City, N. Y., died, April 4, 1961. Affiliate ASME, 1930.

Julius Stanely Morehouse (1894–1961), dean of engineering, Villanova University, Villanova, Pa., died, July 12, 1961. Jun. ASME, 1921; Assoc-Mem. ASME, 1925; Mem. ASME, 1935; Fellow ASME, 1950. In 1956 he received an honorary DS degree from Villanova, and in 1957 was chosen as Delaware County's "Engineer of the Year" by the County Chapter of the Pennsylvania Society of Professional Engineers. He was chairman of various committees in the Philadelphia Section ASME, 1925–1940; chairman of the Philadelphia Section, 1941–1942; honorary chairman of the student branch ASME, Villanova College, 1932–1950; and member of the subcommittee of the Standards Committee on Standardization of Washers, 1940–1961. He was chairman of the National Agenda Committee, ASME, 1941; member of the National Nominating Committee, 1942; and the Medals and Honors Committee, 1948–1958.

Carl Francis Rodolf (1898–1961), assistant water and fuel engineer, Southern Pacific Company, San Francisco, Calif., died, July 5, 1961. Mem. ASME, 1944.

William Crapo Rowse (1883–1961), retired from the Department of Water and Power, City of Los Angeles, Calif., died, June 12, 1961. Jun. ASME, 1912; Mem. ASME, 1961. Author of "Pitot Tubes for Gas Measurements," presented at ASME Annual Meeting, 1913, and published in Transactions of the ASME.

John Clinton Smack (1902–1961), consultant, nondestructive testing, Boonton, N. J., died, April 6, 1961. Assoc-Mem. ASME, 1930; Mem. ASME, 1935.

Francis Meade Tompkins (1909–1961), vice-president in charge of mechanical engineering and purchasing, Chas. H. Tompkins Company, Washington, D. C., died, June, 1961, according to a notice received by the Society. Mem. ASME 1942.

Emil Edwin Weibel (1896–1961), professor of mechanical engineering, University of Colorado, Boulder, Colo., died, June 16, 1961. Mem. ASME, 1936. Author of "Photoelastic Studies" and "Correlation of Fatigue Results on Spring Wire," published in Transactions of the ASME.

William Welch, Jr. (1904–1961), vice-president in charge of engineering, purchasing, and stores, Long Island Lighting Company, L. I., N. Y., died, June 22, 1961. Assoc-Mem. ASME, 1926; Mem. ASME 1937.

Robert Charles Wiren (1896–1961), professor of mechanical engineering, University of Toronto, Toronto, Ont., Canada, died June, 1961, according to a notice received by the Society. Jun. ASME, 1926; Assoc-Mem. ASME, 1930; Mem. ASME, 1935.

Sumer Wolf (1913–1961), manager, engineering and development, Montreal Locomotive Works Ltd., Montreal, Que., Canada, died, July 2, 1961. Mem. ASME 1952.

ASME Codes and Standards Workshop

Erratum

AMERICAN Standard Guide for Selecting Greek Letters Used as Letter Symbols for Engineering Mathematics, ASA Y10.17-1961: On page 4, type faces 37 have been identified as "mu" and it should be "nu."

CANDIDATES FOR MEMBERSHIP AND TRANSFER IN ASME

THE application of each of the candidates listed below is to be voted on after Oct. 25, 1961, provided no objection thereto is made before that date, and provided satisfactory replies have been received from the required number of references. Any member who has either comments or objections should write to the Secretary of The American Society of Mechanical Engineers immediately.

New Applications and • Promotions

Alabama

Kyhl, Curtis D., Fort Rucker
Murphy, James A., Birmingham
•Thompson, Byrd T., Jr., Decatur

California

Chui, King-Wah, Monterey Park
Snell, Richard D., Los Angeles
Winkleblack, Robert K., Woodland Hills

Colorado

Adler, William F., Denver
Bates, Carlos G., Denver

Connecticut

Schmid, Frederick L., Hartford

Florida

Day, Louis W., Jacksonville
Dunlap, Robert H., Tallahassee

• Promotion to Member or Affiliate.

Illinois

Bruen, James P., Chicago
•Danker, Frederick R., Chicago
Martin, James A., Aurora
•Wein, Keith C., Chicago

Iowa

O'Neal, Gene C., Sioux City Airbase

Kansas

Glimm, William F., Jr., Paola

Louisiana

Boyce, John W., Shreveport

Maryland

Lieberman, Albert R., Baltimore
Steffens, Jerome, Silver Spring

Massachusetts

Pascoe, Kenneth H., Lexington

Michigan

Rutkowski, Arthur W., Oak Park

New Jersey

Bernett, Frank E., Princeton
Goldstein, Paul, Carteret
•Hoffmann, Richard A., Trenton
Peitzer, Herbert E., Newark
•Smyth, Sigurd, Westwood
Tiersten, Harry F., Whippany

New York

Beck, Timothy E. H., Allegany
Herskovitz, Arnold, The Bronx
Kanik, Robert W., Utica
Koehler, Herman F., Poughkeepsie
Lyman, Frederic A., New York
Ondrejka, Albert A., Rome
•Pinkus, Alan, East Aurora
Scott, Gerald, Brooklyn
Sherby, Thomas A., Olean

North Carolina

Kelly, Darrell B., Burlington
•Pollock, Robert S., Wilmington
Truitt, Robert W., Raleigh

Ohio

Adams, Otis J., Cleveland
Bernard, Albert S., Dayton
•Langebrake, Clair O., Waverly
Raynaud, Walter L., Wright-Patterson AFB

Pennsylvania

Berlinghof, Charles O., Johnstown
Dixon, John L., Downington
Fuentes, Alberto M., Greensburg
•Shakeshaft, Harold I., Jr., Pittsburgh
•Thornton, Joseph K., Johnstown

South Carolina

Capps, Rutherford B., Hartsville

Tennessee

Nance, Leroy, Fountain City
Wiesehahn, Harry F., Nashville

Texas

Chang, Francis H. S., San Antonio
Fly, Melton L., Houston

Pasche, Albert T., Dallas
Pountain, Gerald L., Houston
Sellers, Adrian I., Houston
Stoerkel, Fred W., Houston
Thomson, John T., Jr., Dallas
Vermeulen, Peter J., Houston

Virginia

•Gill, George E., Waynesboro
Rodrick, Eugene J., Arlington

Washington

Rawat, Canpat L., Spokane

Wisconsin

Gunderson, Allen D., Racine

Foreign

Chaudhary, Yogendra, Dhanbad, Bihar India
Gibson, Eric J., Pickering, Ont., Canada
Labbens, Rene C., Paris, France
Lozano, Guillermo, Bogota, Colombia, S. A.
Manger, Guy R., Zurich, Switzerland
Panjwani, Narain B., Longueuil, P.Q., Canada
Sinha, Kailash P, Dhanbad, Bihar, India
Stegers, Johannes T., Est. Veracruz, Mexico
Tekin, Ahmet Z., Yenisehir-Ankara, Turkey
Wheeler, Dennis H., San Fernando, Trinidad. W. I.

ENGINEERING SOCIETIES PERSONNEL SERVICE. INC [Agency]

These items are listings of the Engineering Societies Personnel Service, Inc. This Service, which co-operates with the national societies of Civil, Electrical, Mechanical, and Mining, Metallurgical and Petroleum Engineers, is available to all engineers, members or nonmembers, and is run on a nonprofit basis.

If you are interested in any of these listings, and are not registered, you may apply by letter or résumé and mail to the office nearest your place of residence, with the understanding that should you secure a position as a result of these listings you will pay the regular employment fee. Upon receipt of your application a copy of our placement-fee agreement, which you agree to sign and return immediately, will be mailed to you by our office. In sending applications be sure to list the key and job number.

When making application for a position include eight cents in stamps for forwarding application.

NEW YORK
8 West 40 St.

CHICAGO
29 East Madison St.

SAN FRANCISCO
57 Post St.

Men Available

Chicago Office

Chief Engineer, MSME; 41; 18 years' experience in design, research; seven years new product development including six years administrative (experience as supervisor and chief engineer heavy machinery, hydraulics, and internal-combustion engines). Open. Immaterial. Me-2271-Chicago.

Recent Graduate Engineer, BME; 23; various nontechnical jobs part-time during school term and summer. Interested in design and development of air conditioning, refrigeration. Compressed engines or heat-transfer equipment. Noncitizen; English good. $6000. West or Midwest. Me-2272-Chicago.

Project Engineer, BSME; registered PE Mo.; 40; substantial experience in plant layout, manufacturing methods, product development, economic studies, extensive customer contact during field-work supervision. $12,000. Will relocate or travel as required. Me-2273-Chicago.

Mechanical Engineer or Plant Engineer, BSME; 34; six years' experience in start-up of new steam-power plants, training operators, supervising construction and maintenance; two years R&D on burners and ignition systems; quality control on components. Open. Immaterial. Me-2274-Chicago.

Mechanical-Design Engineer, BSME; 28; experience in mechanical design and development of electronic components. Desires design work in electromechanical products. $7500 minimum. West Coast or East. Me-2275-Chicago.

Maintenance or Manufacturing Engineer, BSME; 34; nine years diversified engineering in heavy manufacturing, power plants, and process industry, mostly in maintenance and design. PE, Texas. $9000. Midwest or Southwest. Me-2276-Chicago.

Operating-Management Engineer, BSME; 30; 8 years' experience in steel industry, working as assistant general foreman in a six blast-furnace plant. Desires operating position in steel or other manufacturing industry. $15,000. East, Midwest, or West. Me-2277-Chicago.

Project Engineer, BSME; postgraduate work; 41; 18 years' experience in design, development, production, and operation of a wide variety of products, including farm equipment, machine tools, missiles, aircraft equipment, electric motors, and other specialized industrial equipment. $11,000. Me-2278-Chicago.

Design Engineer, BSME; 23; designed and installed centralized lubricating systems and supervised test work on materials for these systems. $6300. Chicago and northern suburbs. Me-2279-Chicago.

Junior Engineer, Sales or Production, recent graduate in mechanical engineering plus extensive course work in nuclear engineering, sales, management, business law, and human relations. Noncitizen. Open. Immaterial. Me-2280-Chicago.

Design Project Manager or Chief Engineer, BSME; 47; 25 years' diversified design and supervisory experience in high-speed automatic machinery and automation equipment, over half of which is in graphic arts. Demonstrated technical and managerial capabilities. $14,000. Immaterial. Me-2281-Chicago.

Engine Development Engineer, BSME, MSME; 43; 18 years' experience in all phases of design, development, and application of diesel, dual-fuel and spark-fired gas engines both two and four cycle. Last position, head, R&D Section, Engine Div. $12,000. Immaterial. Me-2282-Chicago.

General Manager or Executive Assistant; 48; 20 years' experience in general-management administration including engineering, manufacturing, sales promotion, property management. Most recently assistant to president of multiplant company doing $200 million in machinery and equipment field. $20,000. South or Midwest. Me-2283-Chicago.

Test and Development Engineer, BSME; 25; 2 years' experience in test and development of light and heavy farm equipment. Full knowledge of test procedures, including stress and vibration analysis. $8500. Immaterial. Me-2284-Chicago.

New York Office

Project Engineer, BSME; 36, married; 13 years' experience major oil refinery, chemical and mining; cost analyses, estimating, contracts, bid evaluation, design and supervision, material and equipment specifications, and selection including pumps, vessels, tanks, etc. Open. Location immaterial. Me-984.

Mechanical Engineer, BSME; 26; extensive educational background and facility in communication and human relations. Assorted cumulative experience, 5 1/2 years, including three years university teaching. Open. Will relocate and travel. Me-985.

Mechanical Engineer, BME; 29; six months' experience in design, technical writing, customer services. Prefers East. Me-986.

Executive Assistant or Project Manager, MS; 55; 26 years' diversified and progressive experience in Navy shore industrial operations, including production engineering, plant management, industrial relations, quality control, budgeting. management analysis, and contract administration; last ten years in top management. Broad background in government business operation. Open. Southwest or West Coast; will consider others. Me-987.

Supervisor or Senior Engineer, BSME; 13 years' diversified experience in plant layout, material handling, and warehousing. Staff engineer for seven years consulting and training company engineers in U. S. A. and Canada. Project engineer for six years engineering and designing conveyer systems. $13,000 minimum. Optional. Me-988.

Engineering Manager, BSME; outstanding creative and managerial background organizing and operation engineering programs: Product development, design, and engineering services; marketing and manufacturing liaison covering instrumentation, computer, and automation fields. Over $18,000. East preferred. Me-989.

General Manager, BSME; 20 years' diversified experience in general management, marketing, engineering, and production of variety of custom designed mechanical, electrical, hydraulic, and pneumatic equipment, and systems for defense and industry. $22,000. Metropolitan New York or N. J. Me-990.

Plant Engineer, Maintenance Supervisor, ME; registered PE; 35; good background in planning, organizing, and directing plant-engineering activities; excellent experience in machine design, plant layout, and maintenance. Particularly desires growing organization placing emphasis on initiative and creativity. $12,000. Eastern coastal area. Me-991.

Mechanical Engineer, BSME; 25 years' diversified engineering experience as project and mechanical engineer on design, procurement, construction, and operation of mechanical installations in industrial and chemical plants, oil refineries, research laboratories, and office buildings. $10,000. New York, N. Y. Me-992.

Construction or Service Engineer, BSME; eight years' installation and service of steam and gas turbines; four years design and analysis of steam and gas turbines, project management, heat-transfer evaluation. $10,000. Rocky Mountains and West and East Coast. Me-993.

Plant-Engineering Superintendent, MSME; registered; 8 years' experience in process instrumentation, chemical-plant design, general maintenance, personnel administration; four years line supervisor. Desires position with increased management responsibility. $14,000. U.S. Me-994.

Director of Engineering and Maintenance, BSME; Aero major; 21 years of progressively increasing technical and administrative responsibility for the design, analysis, procurement, operation, and maintenance of commercial transport and military aircraft in domestic and international service. $18,000. Southeast or East. Me-995.

Project Engineer, BE (Mech.); 29; six years' project engineering experience in chemical industry, planning and engineering for expansion projects involving many types of chemical-processing equipment; strong practical plant experience. $9000. Will relocate. Me-996.

San Francisco Office

Sales Engineer, Aircraft, Technical, mechanical engineer; 39; six years' experience in technical sales, rocket motors, controls, ground-support equipment, gas turbines, contract administration and proposals, customer presentations. Contacts in aircraft industry and military agencies including Washington, D. C. area. $12,000. Immaterial. Present location, Ariz. Se-1409.

Senior Design Engineer, Consultant, ME; 69; 20 years' experience in the supervision of design of power plants, oil refineries, magnesium plant; seven years' foreign experience. San Francisco area. Se-551.

Designer, Air Conditioning, several years design layout, installation, field survey of semiconductor manufactured equipment, air-conditioning steam plants for industrial use, utilities. $900 month. Immaterial. Se-1088.

Consultant, Management Engineer, Metal Machinery; 55; 17 years' experience in all phases of metalworking-product development, equipment selection, plant layout, time study, inspection, quality, and production controls. $800 month. San Francisco Bay region. Se-1169.

Sales Engineer, Heavy Construction; 38; heavy experience in sales promotion, technical product application, proposal, and contract administration. Background in design, estimating, purchasing, and subcontracting, process and

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[1] All men listed hold some form of ASME membership.

special equipment sales. $700–$850 month. West Coast. Se-1160.

Sales Engineer, Aircraft, Missiles; 42; six years' sales experience on West Coast dealing with missile and aircraft plants, selling hydraulic and pneumatic components, machined parts (pumps, valves, etc.). Northern Calif. Se-544.

Plant Manager, basic industry; 42; 12 years' management experience engaged in design, construction, servicing, and operating heavy industrial equipment and systems in petroleum, paper, power, cement, steel, nonferrous metallurgical and chemical industries. $18,000. West Coast. Se-1147.

Designer, Air Conditioning, Heating; 58; project design air-conditioning public center, aircraft-assembly plants, project engineer involving mechanical process in large industrial plants. $10,000. San Francisco Bay area. Se-1198.

Designer, Pressure Vessels; 35; ten years design and fabrication of heat exchangers, fractionating towers reactors, nuclear steam generators, and other pressure vessels. $12,000. Northern Calif. Se-1003.

Designer, Operator, Process Plant; 29; seven years' experience heavy equipment manufacturing, oil industry, public utilities; in operations, design, maintenance, budgets, and cost. $800 month. San Francisco Bay area. Se-1253.

Designer, Petroleum; 37; instrument and apparatus design background including pressure components and systems with heavy electrical engineering and machine-shop experience. Able to carry a project through from conception to completion. $750 month. San Francisco East Bay. Se-1978.

Plant Engineer, Design, Production; 33; one year applications in monorails, bridge cranes, hoists, power and gravity conveyers, electric trucks, and other material-handling equipment; three years design oil refinery involving general plant maintenance, design, and working with engineers, draftsmen, contractors, plant forces and shops; one-year development involved with fuel tests on IC engines with respect to economy, octane requirement, and vapor lock. $7200. San Francisco East Bay area. Se-1026.

Consulting Engineer, Heating and Air Conditioning; 26; two years' experience heating, air conditioning from layout and installation, to maintenance and repair. $450 month. Denver, Colo. Present location, Canada. Se-1300.

Positions Available

Chicago Office

Project Engineer, Photoprojection Systems, B.S., M.S. in mechanical engineering, physics, optics, graduate-course interests on a company tuition-refund basis; at least three years' experience at project level. Duties will include project engineering associated with photographic lenses and projection systems. $900–$12,000. N. Y. State. C-8828(*b*).

Sales Engineer, graduate, to 35, for work involving selling rotary screw pumps and worm gear speed reducers. $7200–$9000 plus incentive. Territory: Mo., Kan., and Neb. Headquarters, Kansas City, Mo. C-8825.

Rocket Nozzle Designer, mechanical graduate, at least four years' experience in mechanical-hardware design for rocket nozzles. About $12,000. Company pays fee. Ohio. C-8821.

Machine-Design Engineer, mechanical graduate, five years' machine-design experience required. Experience in design of packaging equipment such as filling machines or dry packaging equipment. Work will include new design and improvement of existing design for high-speed automatic closure sealing and closure manufacturing and other closely allied equipment. Must have creative imagination as well as ability to make decisions in proceeding with a choice of approaches involved in a specific problem. Should have personality and articulation to sell his design. $8000–$12,000. Company pays fee. Ohio. C-8808.

Project Design Engineer, graduate mechanical or electrical, to be one of three project engineers on staff of chief engineer. Will work alternately on welding and wire-manufacturing problems. Devise improved production methods and processes. Supervise two draftsmen. Supervise manufacture of equipment made in prototype shop. Ability to visualize improved processes and equipment for arc-welding electrode and chain production based on technical and economic considerations; create these through planning and testing of principles; design of equipment, construction, installation, and debugging. Because of small staff will work mostly independently and in other cases carry out plans visualized by department head. Able to sketch ideas, sell others on ideas, good cost estimator and cost-conscious. Position with a manufacturer of welding equipment and wire products. Company pays fee. Eastern Pa. C-8804.

Purchasing Manager, graduate mechanical engineer desired, to plan and negotiate all purchases necessary for mechanical division engaged in fabrication and erection of heating, ventilating, air conditioning, plumbing, and piping on large scale. Will contact vendors, request bids, analyze bids, and negotiate purchases. Working with production management, will develop substitutes where necessary or for cost purposes. May maintain inventory controls. Will be purchasing large volumes of sheet metal, piping of all kinds, valves, fittings, fans, condensers, and other equipment normal for the industry. $8500. Company will negotiate fee. Headquarters, Pa. C-8795(*b*).

Product Design and Development Engineer, BSME or equivalent, for the design and development of products from idea through pilot production run, for a manufacturer of propane applications. $10,000. Company will negotiate fee. Ill. C-8788.

Steel-Mill Equipment Designer, graduate mechanical preferred, at least five years' experience in actual design of heavy steel-mill rolling equipment. Experience in housing strengths, separating forces, screw down calculations, bearings, spindle sizes, etc. About $10,000. Company pays fee. Chicago, Ill. C-8741.

New York Office

Sales Manager, mechanical graduate preferred, considerable sales and engineering experience in heating and cooling of institutional and commercial buildings to direct and supervise distributors on East Coast from Boston to Atlanta. $10,000–$12,000 plus expenses and bonus. Headquarters, New York, N. Y. W-777.

Sales Engineer, mechanical or chemical graduate, 15 to 20 years' experience selling to the pulp and paper industry, to promote the use and sale of vapor compression evaporation equipment for chemical and industrial waste-recovery systems. Open. New England. W-762.

Staff Industrial Engineer, engineering degree and minimum of five to ten years' working experience preferably in both line and staff, to assist plant managers and plant industrial engineers in planning and carrying out projects on cost reduction, methods, work simplification, material handling, layout, production control, job evaluation, manning requirements, work measurement, wage incentives in process and manufacturing fields. About $10,000. N. Y. State. W-761.

Mechanical Engineer, young, graduate, one to five years' industrial experience, preferably in power-equipment field. Duties will include preliminary design, performance calculations, price estimating, and formal quoting of heavy duty rotating equipment. $6000–$7000. Eastern N. Y. State. W-759.

Chief Engineer, Mechanical, good manufacturing background, to engineer a consumer product from conception to production stage. Company manufactures garden accessories, such as lawn sprinklers, etc. $15,000–$18,000. N. J. W-757.

Quality-Control Supervisor, 26–40, BS in mechanical, chemical, or metallurgical engineering, two to five years' experience in quality control and/or inspection or equivalent time as a design or industrial engineer. Should be experienced in both engineering and manufacturing. Will supervise operation of quality-control section; equipment involved is pressure vessels, heat exchangers, piping, etc., emphasis on stainless steel, aluminum, copper, and brass. $8100–$10,000. Pa. W-741.

Sales Engineer, Injection Molding Plastics, BSME or BSChE preferred. Must be expert in injection mold design to be able to engineer a plastic part from customer's requirements to mass production of the item. Travel: At least one third of work-week away from headquarters. Excellent opportunity. $10,000–$11,500. Headquarters, Conn. W-740.

Design Engineer, graduate mechanical or electrical, up to five years' experience, including some in electrical-distribution system design. Will be responsible for short circuit current calculations, voltage-drop determination, lighting-system layout, equipment specifications and selection and contract estimating. Familiarity with power distribution equipment desirable. Pa. W-737.

Project Engineer, 35–40, graduate mechanical, with graduate courses in aerodynamics desired, to organize and direct a variety of projects, primarily for the purpose of designing and manufacturing medium to large-sized pieces of rotating mechanical equipment. Experience in design of large rotating equipment such as fans and blowers, compressors, turbines, etc.; knowledge of manufacturing and assembling large, heavy rotating machinery; experience in planning and estimating time and costs and organizing and directing major engineering and manufacturing projects. Excellent opportunity. East. W-730.

Machine-Design Engineer, graduate mechanical, experience in machine-design fields with emphasis on moving mechanisms, valves, seals, structures, bearings, etc. Knowledge of limits of high-temperature metals applied to design essential. Will be responsible for development and production of a new product line and requires a design oriented individual. To $10,200. New York, N. Y. W-717.

Manager of Maintenance and Repair, graduate engineer, first-hand knowledge of maintenance requirements of the chemical, petroleum, and petrochemical industries and ability to meet, persuade, and administrate at all levels to take charge of contract maintenance and repair division for a major manufacturer contacting refineries, chemical installations, and petrochemical plants—selling and negotiating maintenance contracts and arranging for performance. Open, plus incentives. Midwest. W-710.

Mechanical Engineers. (*a*) Project engineer graduate, at least ten years' experience covering pulp and paper-mill processes and equipment including estimates of construction and installation of equipment and client contact. $12,000. (*b*) Project engineer, graduate, at least five years' design, specification, and estimating experience on plumbing, heating, air conditioning, etc. $9000–$13,000. East. W-708.

Automotive Engineer, preferably graduate mechanical, at least ten years' experience in automotive design with particular emphasis on chassis and auto parts. $15,000–$20,000. Va. W-699.

San Francisco Office

Design Manager, Paper Machinery, graduate mechanical, 35–45, design and over three years' recent administrative experience in charge of 40, for the design and drafting of heavy machinery in mechanical systems to handle and work converted or processed paper (sheet, cut, lay, convey, band, strap, bead, bale, wrap) newsprint, pulp, ream size to full fordinire roll. Tailor to clients' needs in a protection-job-shop manufacturing operation. $12,000. Pacific Northwest. Sj-6506.

Sales Engineer, Industry Filters, mechanical or chemical graduate, 27–40, to deal with engineering and solving filtration problems involving fluids, valves, pipe, vessels, hydraulics, cryogenics, filters, pressure, temperature, volume. Must be able to contact high-level engineers and handle large dollar-unit sales negotiations. Factory indoctrination. Generous base, expenses, bonus. One for northern Calif.; one for southern Calif. Sj-6496.

Design Engineer, Electromechanical, five to ten years' experience in design assembly, packaging, tooling for small components; knowledge of machine-shop practice, do board work. Some design of automated equipment. Field of electromechanical equipment design for subminiature electronic components manufacturer. To $9600. Marin County, Calif. Sj-6369.

Sales Engineer, Engineering Services, to 35, one to two years inside sales (proposal, contract, report writing, sales forecast, up-dating manuals). Able to write and organize. Will do outside sales after training. For an engineering and construction firm on heavy mill-type equipment. $7800. San Francisco, Calif. Sj-6456.

Valuation Engineer, Depreciable Properties, graduate mechanical or civil, preferably registered, 35–45, to appraise and evaluate equipment, properties, facilities, resources, establish tax base. Will receive indoctrination in law (tax), accounting, depreciation. Will act as expert witness representing federal government. $7500. San Francisco, Calif. Sj-6138.

Designer, Food Machinery, graduate mechanical, 25–32, some food-processing experience; will do project and plant engineering, design labor-saving devices, conveyer lines; food-plant equipment. For cake plant. $5400–$7200. San Francisco East Bay. Sj-6421.

Sales Engineer, Elevators, graduate mechanical, to 26; recent graduate to train for two years in sales technical equipment, installation. Sales ability, technical background. For a manufacturer and installer. To $6420. San Francisco, Calif. Sj-6448.

Designer, Boiler System, mechanical background, qualified in design, layout of low-pressure boiler systems. For consultant. Open. San Francisco, Calif. Sj-6457.

Design Draftsman, Plumbing, Mechanical, to draft and lay out plumbing, AC, steam, double-line large-scale shop drawings. Knowledge of pipe fittings, code on multistory buildings For plumbing contractor. Open. San Francisco, Calif. Sj-6508.

Development Engineer, Analyzer Systems, graduate chemical, mechanical, or electrical, to 35. Systems-design engineer, manufacture automatic chemical-analysis equipment. Design, assemble test to meet nonmilitary clients' specifications, provide programmed system. Experience in small mechanisms design, manufacturing, shop practices; know process instrumentation, deal with management, operations, clientele; plan and supervise for solutions of complex systems. Growth potential with a manufacturer. $10,000–$12,000 plus fringe benefits. Contra Costa County, Calif. Sj-6499.

INSIDE ASME

Nothing Stands Still

The change of the Instruments and Regulators Division to the Automatic Control Division reminds us that established technologies are continually changing. Some, like Automatic Control, are coming up, becoming giants. Gas Turbine Power is already a veteran ASME Division, though it was established as recently as 1947. Curiously, our newest is Maintenance and Plant Engineering, established in 1957. Moved back to inactive status: Wood Industries.

Early this year, the Board on Technology suggested that all Divisions be asked to review their activities to determine if there were not new areas of activity which should be encouraged by the formation of subcommittees to develop and offer programs. Prime example of such a new growth: Solar Energy. Most recent formation: Underwater Technology. From what we observe, here in Editorial, vacuum technology might be a useful line of investigation.

Such committees and groups sometimes serve their purpose and fade out. Others, finding themselves with a burgeoning technology—a tiger by the tail—grow into Divisions.

Old Sol

Ten years ago, solar energy had been relegated to the status of an engineer's hobby.

Today, one of our livelier groups is the ASME Solar Energy Applications Committee. Space flight has put solar energy into business. The men who engineer the harnessing of the sun's energy find themselves contriving hardware for the leap into space, designing power into space vehicles. The solar furnace has become a vaulable research tool.

The Solar Energy Applications Committee is having one of its most active years. They'll have one session—maybe two—at the Winter Annual Meeting. Plan to drop in.

Underwater Technology

The Council has approved the organization of an Underwater Technology Professional Group whose field of interest will be: Underwater vehicles, transport, and propulsion; underwater shock, underwater noise, underwater drilling, oceanography equipment. If it thrives, and its technology grows in importance . . . that's how Divisions are born.

This new group plans a symposium to be presented at the Winter Annual Meeting, week of Nov. 26, 1961. Watch for it. If it doesn't conflict with other sessions, you must attend, drop in and hear the latest on submarines.

Food, Anybody?

That last banquet you attended (with speeches): Was it worth $9.50? The Petroleum Division, according to its latest News Letter, takes a dim view.

They've been looking at the record. A Division receives its operating income from the registration fees at Conferences: The host Section traditionally covers its costs by making a profit from the "meal functions" (awkward phrase), such as the Welcoming Luncheon, Industry Luncheons, Evening Banquet. Petroleum finds that while Conference attendance has increased, participation at the dining-room gatherings has declined. To balance this decline, the host Section added still more to the price. Still lower attendance.

Their conclusion: "When the Petroleum Division analyzed its true objective for holding a Conference, it was obvious that the thing we desired most is high registration and attendance at the paper presentations. It is our belief that the local Section should have its incentive directed toward this end.

". . . The registration fee for the Kansas City Conference will be increased $2 over the fee previously charged. The meal functions will be reduced to the actual hotel cost, with no override. The Kansas City Section's financial results will depend on the number of Conference registrants, and not on the unpredictable attendance at the evening banquet."

Have the black-gold boys got an idea for the other 23 Divisions?

The Strong Back

Division News Letters can be lively reading—quite apart from the fact that they keep you up on the latest Division activities. A recent Letter from the Materials Handling Division contains a brief comparison between the cost of electric power and muscle power.

"Assuming that a reasonably able-bodied man can generate about 1/10 hp over a period of time, it will take him 10 hr to produce one horsepower/hour of energy . . . it will take him $13^1/_2$ hr to produce one kw or its equivalent.

"At a minimum wage of $1 for 'Labor, unskilled, material handling' (Bureau of Labor Statistics term), the cost per kwhr is $13.33. This is 885 times as much as the cost of the same amount of electrical energy purchased at $1^1/_2$ cents per kwhr. At the BSL rate reported for Cleveland ($2.25), that ratio goes up to an even 2000 to 1. If you have a skilled mechanic at $3.50 an hour doing manual handling work at times, his horsepower output is costing you $46.70 a kwhr and the ratio of muscle-generated power over electrical energy becomes 3100 to 1."

Not Born Yesterday

Item from the August, 1961, News Letter of the Power Division: "Agreement has been reached with AIEE to hold the 1964 National Power Conference in Tulsa, Okla., on Sept. 9–11, 1964."

Think that's planning far ahead? Well, we can tell you that the 1965 Winter Annual Meeting is scheduled for Chicago: The Applied Mechanics Conference of 1964 will be in Boulder, Colo: The Joint Railroad Conference (ASME-AIEE) for 1964 will be in Philadelphia. These events don't just happen. They are planned and developed far in advance by dedicated Members on the Division Committees, and the Regional and Sectional Committees. This is particularly true where a Conference is to be held jointly with another society, a growing trend in co-operation between the societies.

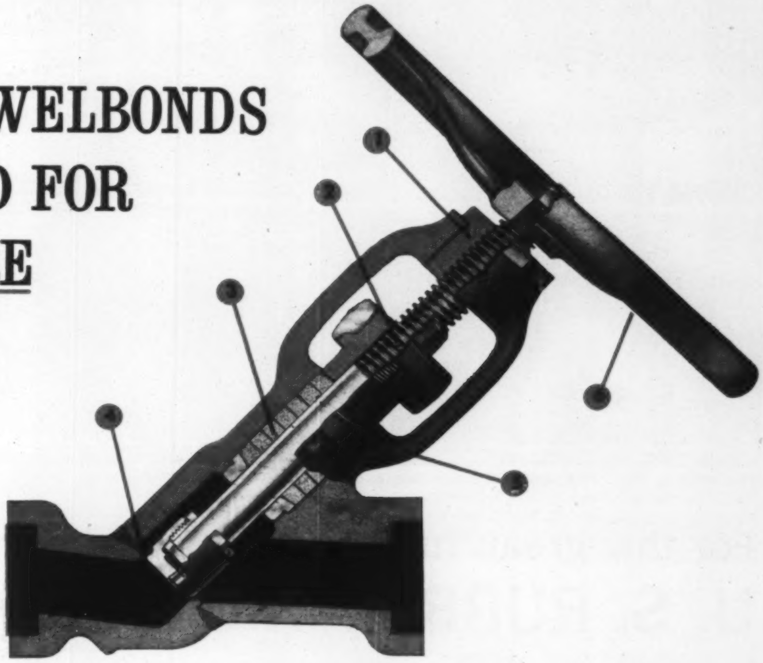
—*Maurice Barrangon.*

YARWAY Y news briefs

from **Yarnall-Waring Company,** *Philadelphia 18, Pa.*

BRANCH OFFICES IN 19 UNITED STATES CITIES • SALES REPRESENTATIVES THROUGHOUT THE WORLD

WHY YARWAY WELBONDS ARE SPECIFIED FOR HIGH PRESSURE VALVE JOBS



Yarway Welbond Valves (sizes ¼″ through 2½″) have won resounding acceptance from boiler room operators everywhere because of these 6 unique features—resulting in *outstanding performance* that is *dependable* and *trouble-free:*

① Full **accessibility**—all working parts readily removed through top of yoke. Jack action of stem forces out old packing.

② Guided valve stem of **#321 stainless steel**—will not "pit." Self-aligning, stellite-faced disc.

③ High temperature **inhibited stem packing** furnishes double insurance against packing leaks.

④ Unique seat design with thermal compensating groove that **prevents distortion** during assembly welding and when welding valve into line. Also permits perfect seating of disc for tight seal. Integral seat is stellite-faced.

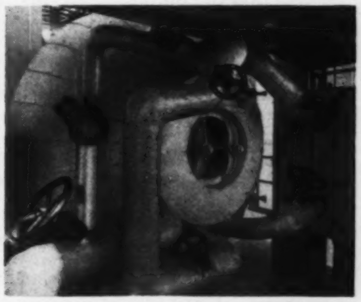
⑤ **One-piece** forged chrome-moly steel body and yoke.

⑥ Easy-grip, **ventilated handwheel**—makes operating a "breeze".

More details—and list of users? Write Yarway. Ask for Bulletin B-454.

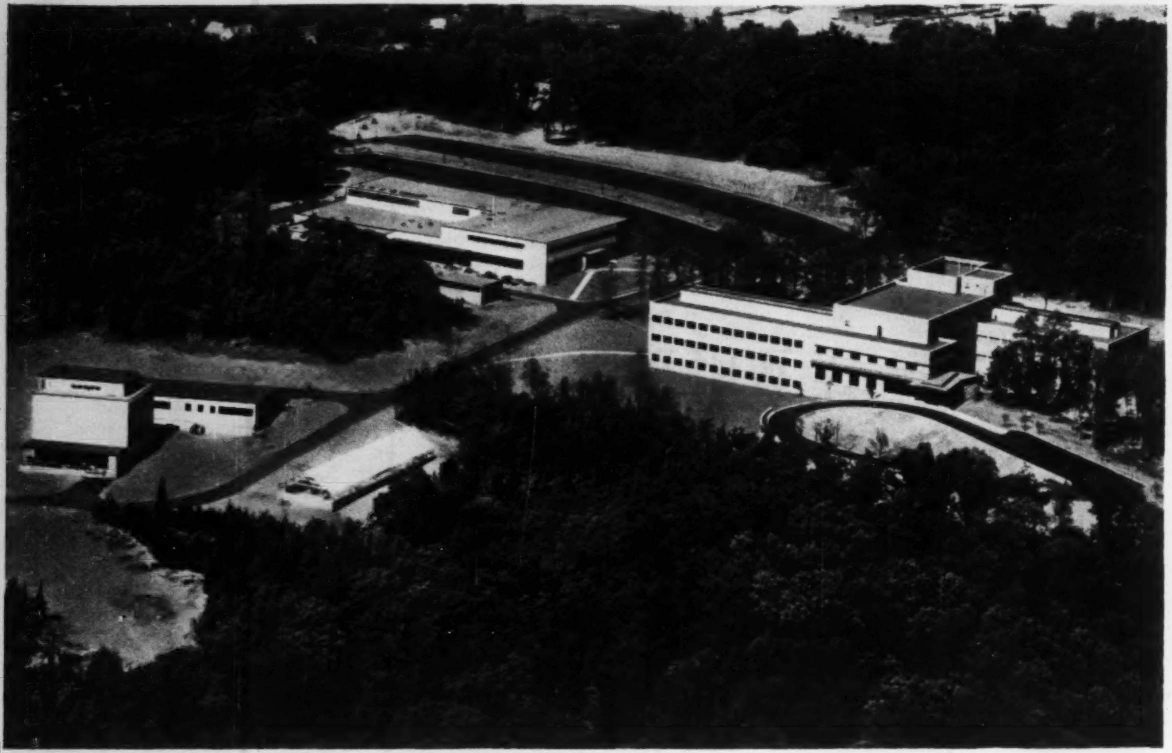
Four of many Yarway Welbonds installed in large eastern public utility plant. Steam pressure 1850 psi; temperature 1000°F.

Four Yarway Welbonds on main steam line to turbine at southern power plant. Press. 2310 psi; temp. 1000°F. Over 100 Welbonds here.



Six of 900 Yarway Welbonds at southwest utility. Boiler drum pressure in this plant—2150 psi; superheat temperature 1005°F.

Circle No. 142 on Readers' Service Card



Chemical Eng. Bldg. at left; Mechanical Eng. Bldg. at center; Main Research Bldg. at right.

For this great, future-probing

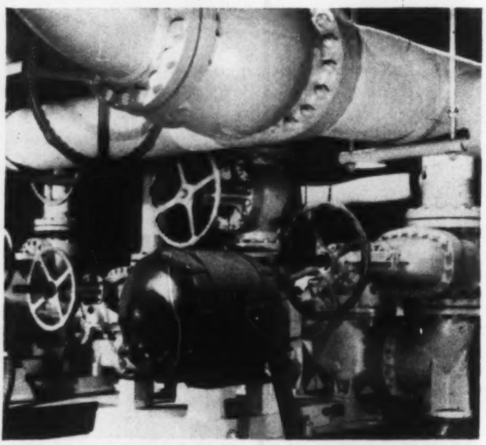
U. S. RUBBER RESEARCH CENTER

JENKINS VALVES assure trouble-free control of the entire piping system

Here, in a complex of modern buildings on a wooded New Jersey hilltop, a staff of over 400 are making tomorrow's miracles out of today's mysteries. Here, they're future-probing the possibilities in rubber and tires, of course. But the quest also covers all the other present-day interests of U. S. Rubber Co. . . . plastics, chemicals, textiles, and endless uses of such materials.

The Research Center scientists and building experts controlled the selection of equipment for their $7,000,000 "home." Jenkins Valves were widely used to control the piping systems.

Make the specification "JENKINS" *your* safeguard against valve trouble and the high cost of valve maintenance. *You pay no more* for Jenkins Valves. Jenkins Bros., 100 Park Ave., New York 17.



Thousands of Jenkins Valves control the piping system.

Architects: Shreve, Lamb & Harmon
General Contractor: George A. Fuller Company
Consulting Engineer: Syska & Hennessy, Inc.
Heating, Air Conditioning, Piping Contractor: Frank A. McBride

Available From Leading Distributors Everywhere

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VALVES
JENKINS®
SINCE 1864
Jenkins Bros

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KEEP INFORMED

NEW EQUIPMENT
BUSINESS NOTES
LATEST CATALOGS

Available literature or information may be secured by using convenient Reader Service Card on Page 149

NEW EQUIPMENT

Thread Repair Kit

A thread repair kit for the restoration of stripped, worn or damaged metric threads has been introduced by Heli-Coil Corp.

The kit was designed and manufactured especially for Volkswagenwerk, A.G., by Bollhoff & Co., Heli-Coil Corporation's West German licensee. It contains a quantity of M6, M7, M8, M10, M12 × 1.5 and M14 × 1.5 stainless-steel wire "Heli-Coil" screw-thread inserts; the necessary taps and inserting tools, along with complete German and English instructions.

Although originally made for Volkswagen applications, this Heli-Coil thread repair kit is recommended for any thread repair in the furnished sizes for foreign-made automobiles, machine tools and other products assembled with metric threads.

Heli-Coil inserts are precison formed 18-8 stainless-steel wire thread reliners for stripped or worn tapped holes in any material. They are installed easily—simply drill out the damaged threads, tap with a "Heli-Coil" tap and install the insert. They are invisible in assembly and permanently restore the thread to original size and specification.

—K-1

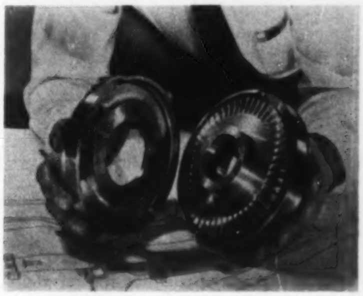
Solid Lubricants

"Poxylube," a product of POLY CHEM, is said to be a unique development in solid lubricants in that it requires only vapor degreasing to produce excellent adhesion on a great variety of surfaces. The special qualities and application principles of this lubricant are given in some detail in a recent folder. **—K-2**

Self-Locking Nut

A small, lightweight stainless-steel fastener, designed for installation in sheets 0.040 in. thick and up, is being produced by Penn Engineering & Mfg. Corp. It is self-locking, with high push-out and torque values, and is flush on the reverse side of the sheet.

This style nut is suitable for temperatures up to 800 F, and for use in materials with Rockwell hardness B-75 or less. Class 3-B threads are coated with dry film lubricant; Available sizes No. 4 to 10. **—K-3**



Turbine Pumps

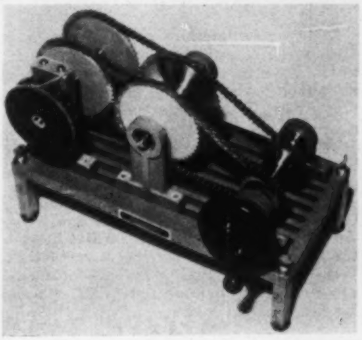
Worthington Corp. has introduction of a new line of turbine pumps designed for high-head, low-capacity service. Its unique characteristics make the turbine pump particularly useful for power plants, laundries, breweries, general water service, boiler feed, and condensate service.

The turbine pump operates on a unique pumping principle—pressure regeneration—by which a multivaned impeller engages and reengages the liquid to develop high heads in a single stage. This regeneration cycle is repeated as many as fifty times as pressure is built up in the pump. When the liquid reaches the discharge opening, it is allowed to escape and a close-clearance stripper in the plates prevents the flow from continuing on to the suction area.

An extra husky shaft and oversized bearing permit a design that delivers pressures up to 30 per cent higher than competitive models without going to two stages, according to the company. The pump will operate satisfactorily with inlet pressures up to 150 psi. They also are self-priming and can operate on suction lift conditions.

The turbine pump is available as a close-coupled monobloc pump as well as frame mounted. Also, the motors are interchangeable with those used on the Worthington end-suction line of centrifugal pumps.

—K-4



Chain and Sprockets

A complete line of precision chain and sprockets is now available from stock, for immediate delivery, from PIC Design Corp. Supplied in Type 18-8 nonmagnetic, stainless steel, this new 0.1475 pitch chain is stocked in lengths ranging from 5.900 to 57.525 in., with special lengths available upon request. The chain is said to be ideal for use in all servomechanism, data recording, or mechanical motion applications, offering distinct design advantages in the elimination of slippage, noise and excess backlash. Light in weight, it offers high reduction capabilities, with extremely low torque factor.

Pin-type hub sprockets are stocked in 1/8, 3/16 and 1/4-in. shaft sizes, with hubless type sprockets available in a 3/8-in. bore size. All sprockets may be ordered in stainless steel, aluminum, linen phenolic, or nylon, to best meet planned operating conditions or design requirements. **—K-5**

Heat-Exchanger Motors

Totally enclosed d-c motors featuring a newly designed aluminum air-to-air heat exchanger in ratings 75 to 250 hp at 1150 rpm are offered by the Westinghouse Electric Corp. Generators in corresponding ratings are available also.

An a-c totally enclosed vertical motor, to drive the blowers, is recessed in the d-c motor commutator bracket to reduce the over-all height of the complete unit. The compact heat exchanger is made up of welded fin-type aluminum ducts. An internal blower pulls hot air from inside the motor through the ducts, while an external blower pulls air over the ducts and discharges heated air through the dripproof front end of the heat exchanger, providing maximum efficiency.

A constant rate of cooling is obtained when operating at reduced speeds. The result is increased speed range available under full-load conditions as compared to an equivalent size fan-cooled motor. **—K-6**

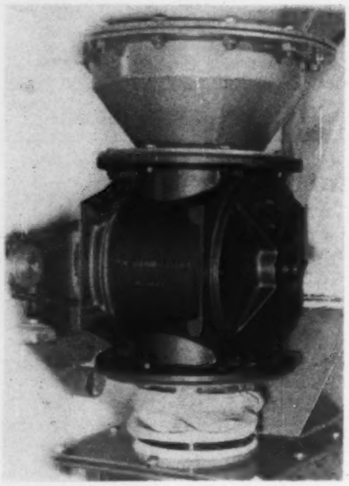
Increase Efficiency Reduce Cost with
FLO-TRONICS AIR CONVEYING
SYSTEMS and EQUIPMENT

Flo-Tronics complete air conveying systems and system components are designed to meet your specific requirements. Systems include complete automatic controls. Equipment is available as standard, in cast iron, chrome-plated, Ni-Resist and stainless steel construction.

ROTARY AIRLOCK

Meters powdered or granular product discharge efficiently from bin, hopper or tank. Controls product flow into equipment with fixed handling rates. Inlet design is extra large for most efficient product movement. One-piece end plates house the double-lip shaft seal and outboard shaft bearings. Rotor blades are available with replaceable, adjustable tips. Available in sizes from 0.3 to 2.0 cu. ft. per revolution.

Flo-Tronics engineers are anxious to assist you with your air conveying problems. Write today for Rotary Airlock product sheet and air conveying systems brochure. No obligation of course.



FLO-TRONICS, INC.
Air Conveying Division
1438 Zarthan Avenue
Minneapolis 16, Minnesota

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KEEP INFORMED

BUSINESS NOTES
NEW EQUIPMENT
LATEST CATALOGS

Twelve-Pole Military Motor

Designed for specified application in air conditioning and refrigeration units used in military ground-support applications, a new 400-cycle, 12-pole partial motor has been introduced by U. S. Electrical Motors, Inc.

This 3800-rpm motor is designed to be directly interchangeable with 60-cycle, 2-pole motors powering standard compressors. Such interchangeability greatly facilitates conversion of existing or proposed equipment to 400-cycle operation, where 400 cycle is the prime or only power system available.

The 400-cycle, 12-pole partial motor is built specifically for hermetically sealed operation. It is available in standard NEMA sizes and specifications. Stator diameters available are 4.44, 5.48, and 6.29 in. —K–7

Tube Axial Fan

Electro Products Div. of Western Gear Corp. announces the design and manufacture of a tube axial fan, Model F234-1, for application in electronic spot cooling or chassis cooling in missile, avionics, and ground-support programs.

This fan has an input of 3-phase or 1-phase, 400 cycle, with an output of 100 cfm at 0.25 in. static pressure at 55,000 ft altitude, or 58 cfm at 1.0 in. static pressure at sea level. Weight is 0.72 lb. Size is $2^1/_4$ in. length by 3-in. diam at mounting rings. Mounting is by servotype clamping rings at both ends for either panel or duct mounting. Other features include terminal strip and mil-spec applications. —K–8

Plate Scrubber

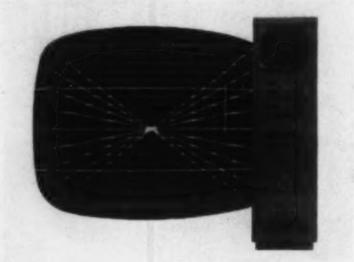
John Wood Co., designers, developers, and manufacturers of air-pollution control equipment, details the operation of the flooded plate scrubber for the collection of fumes, mists, vapors and particulate matter, from exhaust gases and process equipment, in a four-page bulletin, No. 170.

Exhaust gases, dispersed into minute bubbles, are subjected to thorough and repeated scrubbing actions to efficiently and economically remove difficult, obnoxious and corrosive-entrained contaminants. Features of the flooded plate scrubber are operational simplicity, high collection efficiency, low liquid consumption and low operating costs. —K–9

Radial Feed Head

A new continuous radial feed head—the CF-6E—has been added to the Davis "CF" line of precision heads for small-diameter boring, facing, turning, backfacing, grooving, and chamfering operations. It provides 4 in. of uninterrupted radial tool feed (standard CF-6 heads feature 2 in. of tool feed). Boring range is from $^7/_{16}$ in. (with pencil boring tools) to a recommended maximum of 18 in. diam. Catalog No. D-530-A issued by Giddings & Lewis Machine Tool Co. contains pertinent data.

Design features of the new head include adjustable depth of feed stops, a safety clutch which releases under overload, micrometer adjustment for radial tool positioning in increments of 0.0001 in., and rigid tool slide clamping for heavy boring and turning operations. —K–10



Calibrated Display System

Philbrick Researches, Inc., has announced its Model 5934 multi-channel calibrated display system. The new Philbrick unit offers high accuracy and high-speed readout. Model 5934 will display simultaneously on a 17-in. cathode-ray tube up to eight input signals superimposed on an electronically generated co-ordinate system. Because the signal waveforms and the co-ordinate system are displayed simultaneously, all errors from distortion and nonlinearity are eliminated. Signals can be plotted on this electronic "graph paper" to better than 0.2 per cent accuracy. The basic unit is standardized to provide full-scale deflection for ±100 volts. An optional preamplifier unit permits expansion and zero-shifting of small signals.

The 5934 display system offers a wide choice of display periods for both high-speed and low-speed computer operation, ranging from 25 millisec to 50 sec. Input signals and voltages for producing co-ordinate lines are sampled every 62.5 microsec for display. The time reference is furnished by a precision crystal oscillator, which triggers a vertical flying scan deflection system.

The entire system consists of five chasses including the display unit, control circuits, and power supplies, plus the optional preamplifier units—all of which can be mounted in a single standard cabinet. —K–11

Motorized Power Packages

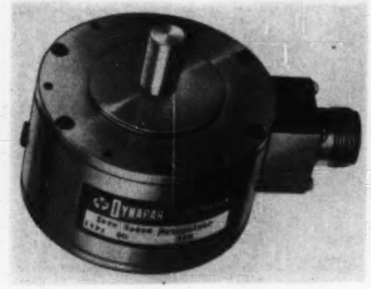
New motorized hydraulic power packages developed by Vickers Inc., Div. of Sperry Rand Corp., incorporate a pump, motor, valving, and reservoir in one compact assembly. A unique, efficient design in which the pump is connected to the extended shaft of the electric motor, contributes to ease of installation and operating dependability. The low-cost power packages can be used in virtually any machine application, including dockboards, scissors lifts, small press brakes, paper cutters, baling presses, tube benders and welding machines.

The units are availabe in three different series, with outputs to 8 gpm with pressures to 1500 psi.

Electric motors are offered in five sizes from 1 to 5 hp at 1800 rpm—either 220/440 volt, three-phase or 115/230 volt, single-phase. All are totally enclosed, fan-cooled, 55 C heat rise and have class "B" insulation for maximum reliability. —K–12

KEEP INFORMED

BUSINESS NOTES
NEW EQUIPMENT
LATEST CATALOGS



Sensing Devices

Dynapar Corp., electronic subsidiary of The Louis Allis Co., recently announced the introduction of a complete line of digital "Rotopulser" sensing devices for precise industrial measure and automation control.

The Rotopulser is a ruggedly constructed rotary transducer which converts mechanical motion into digital voltage pulses. These pulses provide numerical readout of the measurement and actuation of any desired automatic control functions in either batching or continuous process operations.

Rotopulsers are available in two basic designs (zero speed and magnetic type) which provide any required accuracy and transfer information over any distance without error or drift and require no calibration adjustments. They are designed for use with preset counters, controllers, tachometers, totalizers, rate indicators, and many other readout and control devices. They provide measurements of length down to 1/1000th in. for automatic cutting-to-length or bidirectional positioning applications or speed measurements down to 1/100 rpm for roll speed, elongation or paper draw measurements. Request Bulletin 200. **—K-13**

Reverse Flow Check Valve

Harris Calorific Co. has announced a new group of reverse flow check valves that fit all makes of torches, line regulators and cylinder regulators. These safety check valves stop dangerous contamination of oxygen regulators by fuel gas and prevent oxygen from entering the gas regulator. Torch models prevent the gases from mixing in the hoses, a common cause of explosions and fires.

Installation of the check valve is fast and easy. Regulator models replace the outlet nipple and fit all makes of line and cylinder regulators. Torch models screw onto the hose connection of the torch and the hose is attached to the check valve. **—K-14**

FOR CONSULTING ENGINEERS
TURN TO PAGE 174

GLANDLESS PUMPS for efficient operation at rates from

7 to 35,000 gal/hr

RATIER PUMPS PROVIDE LEAK-FREE SERVICE FOR NUCLEAR, CHEMICAL & STEAM-BOILER APPLICATIONS

For the pumping of hot, highly-corrosive, toxic and radioactive liquids . . . maximum differential heads of up to 400 feet of water can be handled at static heads of up to 2200 p.s.i. . . . temperatures up to 700°F.

The photo above shows a group of pumps for circulation or pumping against a head of 32.8 feet maximum; flooded suction; self-priming; capacity (each pump): 4200 gal/hr.

Both canned-motor and wet-motor styles are available. Canned-motor pumps feature a stainless steel-encased (or other corrosion-resistant materials) stator which prevents fluid from coming in contact with electrical windings; these units are designed to pump highly-corrosive liquids. Wet-motor units are designed for relatively non-corrosive liquids including water . . . totally seal-welded units for radioactive liquids.

SEND FOR BULLETIN: Aminco has printed a new Bulletin (No. 4076) describing and illustrating the many models available; yours on request.

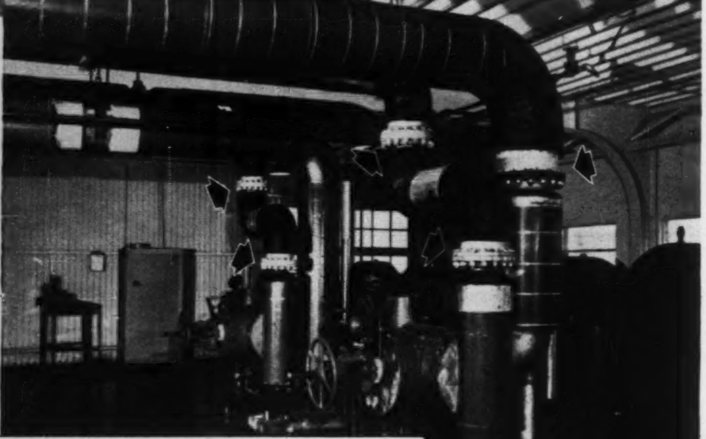
RATIER PUMPS are imported by and exclusively distributed in North America by Aminco.

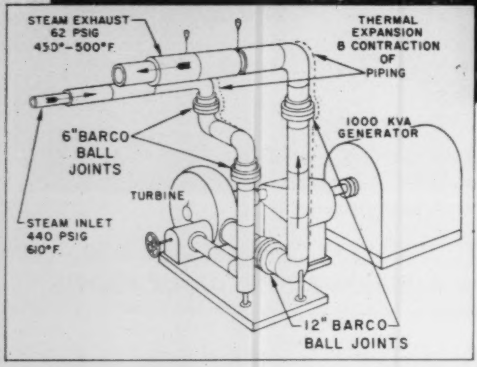
AMINCO

AMERICAN INSTRUMENT CO., INC.
8030 Georgia Ave., Silver Spring, Maryland

Circle No. 175 on Readers' Service Card

Barco Handles Expansion on Steam Turbine Piping–





BARCO

BALL JOINTS

1. Handle Expansion **2.** Relieve Torsion **3.** No "End Thrust"

PROBLEM For the turbine installation shown above, layout of the piping presented involved pipe stress calculations to allow for thermal expansion and to eliminate torsional effects. In addition, a considerable expenditure had to be allocated to cover construction of heavy pipe anchoring and to control expansion "end thrust". *Could engineers find a better way to solve these problems? THEY DID! . . . and they saved about $2,000.00.*

ANSWER Instructions were simple: (A) "Install Barco Ball Joints —two* in each riser near turbine." (B) "Cut loose anchor stops; allow piping to move freely in all directions." (C) "Use spring hanger supports for the long horizontal runs of piping."

*Standard Type N for exhaust; High Temperature Type HT Joints for steam inlet lines.

Barco Ball Joints provide convenient points of flexibility in piping to allow for both expansion and twisting. They develop NO "END THRUST"; expensive anchoring is not required. Easy to engineer. Rugged all-steel construction with no thin wall sections, no critical points of fatigue, no rubber seals. No lubrication required. Sizes and styles to meet your requirements. *Ask for new Bulletin 31B, "Thermal Expansion and Contraction in Piping."*

BARCO MANUFACTURING CO.
521L Hough Street, Barrington, Illinois
In Canada: The Holden Co., Ltd., Montreal

MOVES IN ANY DIRECTION

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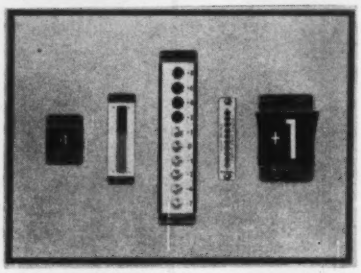
BUSINESS NOTES
NEW EQUIPMENT
LATEST CATALOGS



Remote Water Gage

An electrically operated remote water-level indicating system that requires no pressure connections or compensating devices has been introduced by The Reliance Gauge Column Co.

Called Electro Eye-Hye, the system detects water level with electrodes in a direct-to-drum water column that is recommended by the manufacturer for service pressures up to 3000 psi steam and 5000 psi cold. All connections between the water column and the panel indicators are electric, permitting placement of single or repeater indicators at any distance—without pressure connections.

Five different indicators are available. Three are ten-light indicators which register liquid levels on a column of lights, providing 180-deg visibility. Two are digital readouts which project the liquid level—in inches above or below normal—onto a self-contained screen. **—K-15**

Fraction Motor Bearings

Three improvements in traction motor bearings are engineered into the new SKF Industries, Inc., "Hi-Miler" bearing.

"High-arc" design produces cage-roller contact at the greatest possible distance from the roller pitch diameter. As a result, the cage imposes less pressure on rollers, roller load is reduced, and the danger of cage-wedging between rollers eliminated. A new tapered flange concentrates the contact area toward the outside of the roller end and at the base of the flange, the region of slowest relative motion between roller face and flange. Roller rotation builds up a highly beneficial oil wedge with a hydrodynamic compression that maintains a safe, non-smearing unit pressure between the two surfaces for all thrust conditions.

Surface finish is measured in microinches by a profilometer and a waviness test machine for indicating the geometrical trueness of rolling surfaces.

Combining lower friction of rolling and sliding surfaces with the new flange design and improved cage construction, the SKF bearing achieves a new low in operating temperatures as less heat means more effective lubrication and long bearing life.

—K-16

KEEP INFORMED

BUSINESS NOTES
NEW EQUIPMENT
LATEST CATALOGS

Bearing Tester

The first bearing test apparatus for measuring radial play in ball, roller, and self-aligning bearings is now available from Southwest Products Co. Developed by Southwest for use on its "Monoball" self-aligning, spherical bearings, a spring pressure gage is provided to permit a constant pressure reading for each bearing. The gage registers in increments of one tenth of a thousandth inch. Usage is applicable to all types of bearings where there is an inner and outer race. The new test apparatus carries U. S. Patent No. 2,852,853.

It checks radial play in antifriction bearing of 5-mm to 38-mm bore and other models to 153-mm bore. It handles self-aligning bearings in a size range from $^1/_8$ to 1.50-in. bore and other models to 6-in. bore.

Simple and easy to operate, the Southwest bearing test apparatus is of precision construction, with a heavy-duty frame. It measures 14 in. long × 12-in. wide and $12^1/_2$-in. high and is suitable for bench use in quality-control inspection. **—K-17**

Automatic Centrifugal Clutches

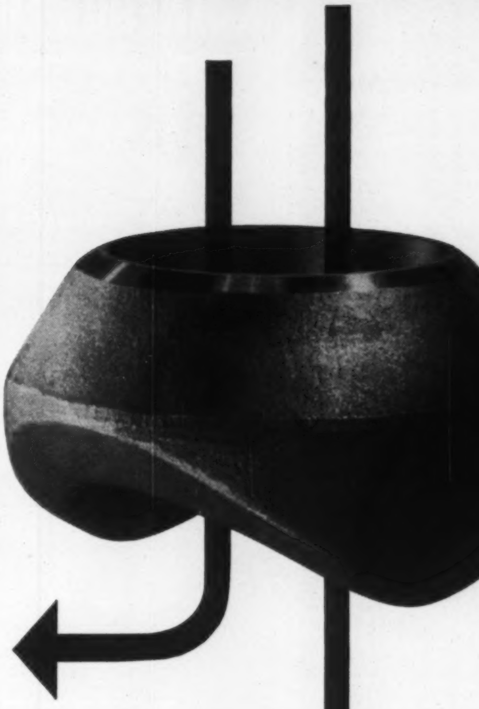
Rawson automatic centrifugal clutches and clutch couplings designed for a wide range of industrial power-transmission applications are reviewed in a revised and enlarged, 42-page catalog published by the Formsprag Co.

The catalog, No. 142, gives mechanical and design engineers a convenient quick-reference guide and fact file on these simplified, compact, all-metal clutches, their basic functions, principal advantages, and performance characteristics. Factors covering clutch selection, typical application examples, and dimensional data (keyed to cross-sectional drawings) are discussed for the six standard types of clutches available for direct or indirect-drive applications requiring either free or delayed engagement. Also included are a number of tables, charts, and graphs covering horsepower ratings, service factors, allowable acceleration, and representative mounting arrangements.

Supplementing these subjects are illustrations of eight typical Rawson clutch applications in as many different industries as well as helpful hints on installation, lubrication, maintenance, and the manufacturer's special design service. **—K-18**

Use a CLASSIFIED
ADVERTISEMENT
For Quick Results

BONNEY WELDOLETS



cut corners safely...

ON ALL 90° BRANCH PIPE CONNECTIONS

Competitive economic times like these make cost cutting mandatory. Reduce piping costs by using Weldolets instead of welding tees for all full size and reducing branch connections. Contractors and owners are saving thousands of dollars on piping jobs by switching to Weldolets. Are you? Write for information.

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THREDOLETS®
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CARBON STEEL
STAINLESS
ALLOY
for all services

BONNEY FORGE AND TOOL WORKS, ALLENTOWN, PA.
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MECHANICAL ENGINEERS

needs you for

DEVELOPMENT ENGINEER

For new Desomatic Division for development in fields of air treating and gas drying concerned with dehumidification. To work on existing projects & new project proposal preparation. B.S., M.S., mechanical engineering with experience in engineering calculations, structural design, sheet metal, welding, electrical power circuitry, and general light fabrication.

DESIGN ENGINEERS

To work in Rocket Design Section on design and development of high-performance rocket motor light-weight hardware. Design scope involves inert component design, knowledge of gas dynamics for solid propellant rocket nozzle design. pressure vessel construction, and metallic and non-metallic materials applications. B.S., M.S. in mechanical or aeronautical engineering with experience.

R & D APPLIED MECHANICS—STAFF ENGINEER

To work with Mechanical Engineering Division Director as applied mechanics specialist in fields of stress, heat transfer. and thermodynamics, on both practical problems and the organization of original R & D proposals. M.S. in mechanical engineering with good academic record.

ROCKET PROJECT ENGINEERS

To work on prototype development of solid propellant rocket propulsion systems. Involves coordination of programs with mechanical design, ballistic, instrumentation, and test engineers. Requires personable men with interests and demonstrated abilities to carry systems from inception through test and qualification. B.S. or M.S. in mechanical or chemical engineering with the ability to work effectively with others.

JR. SYSTEMS ENGINEER

Responsible for cost estimate and schedule preparation for proposed R & D and manufacturing projects, as well as cost and schedule monitoring, maintenance of current programs. He must be capable of working closely with responsible, advisory, and liaison personnel. B.S. in mechanical or industrial engineering, experience in project engineering cost estimating, and manufacturing liaison.

TECHNICAL REPRESENTATIVE

For the Desomatic Division's work in air treating, heat exchange and gas drying equipment; to contact government agencies and develop areas for submission of work proposals, participate in preparation and presentation of proposals to interested government agencies. Requires 5–10 years' experience in development or sales work in defense contracting. Knowledge of air and gas handling helpful, B.S. mechanical or industrial engineering.

Atlantic Research Corporation is an expanding contract research and development company, located in the Washington, D. C. Metropolitan area. Its technical interests range from solid propellant rocket development and manufacture, through electronics and electromechanical instrumentation, to research and development of new and improved plastic materials.

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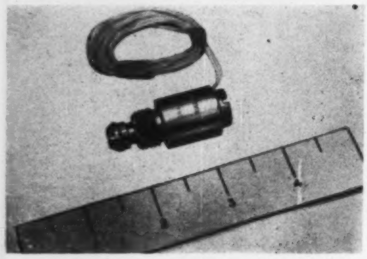

Cryogenic Valves

Hardened seats for longer life are featured in the new Hydraulic Research & Mfg. Co. miniature cryogenic valves designed for the missile industry. The valves range from 100 to 4000 psi in capacity, and operate dependably in a temperature range from −425 to +300 F. The valves are production items.

According to the manufacturer, the extremely low degree of internal leakage is an advancement in design of cryogenic valves. Functional tests using 1000 actuations at various temperatures showed zero leakage in the 70 F range where leakage low as 0.5cc at −300 F at 3000 psi. **—K–19**

Differential Regulator

OPW-Jordan Corp. has announced a new differential pressure regulator, the No. 167 series valve, available in ductile iron or bronze from stock in $^1/_4$, $^3/_8$, $^1/_2$, and $^3/_4$-in. sizes. The pressure differential regulator maintains a constant differential between the medium passing through the regulator and any other medium loaded on top of the diaphragm. It has wide usage in the paper, chemical, and other processing industries. It is suitable for steam, water, air, oil, gas, or chemicals.

The valves are suitable for 250 psi at 450 F and 300 psi at 150 F and are designed for differential pressures up to 125 psi with control ranges 2–30, 15–70, 20–85, and 40–170 psi. The valve features selfcleaning, selflapping, stainless-steel "Sliding Gate" seats as standard and all-metal construction. **—K–20**

Hydraulic Presses

South Bend Lathe complete line of presses, 30, 50, 75, and 100-ton Hydrolair and the 30-ton Hydraulic Laboratory, are currently being featured in a two-color, eight-page catalog, No. 6106, with complete ordering information.

Specifications on all air-powered Hydrolair and hydraulic presses, hot plates and accessories are listed in separate sections in detail for easy reference. Color diagrams of the "Power-Petuator" air-hydraulic intensifier provide a clear explanation of this unique, patented feature. One section is devoted to the 30-ton bench type laboratory press. **—K–21**

Quarter-Turn Fasteners

The Palnut Co. is marketing low-cost, onepiece, lightweight, spring steel, quarter-turn fasteners which are used for blind fastenings scuh as attaching back panels of TV sets, refrigerators, stoves, washers; as latching mechanisms for access panels; for securing reflector panels to fluorescent lighting fixtures, and similar light-duty applications.

Both fasteners are much lighter in weight and lower in cost than existing quarter-turn fasteners. They ar self-retaining in outer panel, avoiding displacement when asembly is opened. Both types feature a barrel shank to keep the fastener centered in the hole and to add shear resistance.

Part No. QA50080 is designed for easy finger assembly and is locked and unlocked by pressing firmly with fingers and rotating 90 deg in either direction.

Part No. ZOOO1529 is assembled by pushing into panel holes, then inserting a screw driver into the fastener slot, depressing arched head and rotating 90 deg. To disassemble, the screw driver is rotated in the opposite direction. This fastener provides an almost-flush surface with the outer panel. **—K–22**

Close-Coupled Pumps

Especially designed for high efficiency and practical economy, Type GBH pumps, announced by Aurora Pump Div., New York Air Brake Co., are said to provide required capacities and heads with less horsepower, reducing initial investment and operating costs. Capacities range up to 1600 gpm and heads to 330 ft. Maximum compactness with close-coupled end-suction design saves valuable space, permits fast installation, and makes these pumps especially suitable for OEM applications, air-conditioning systems, cooling towers, boiler feed, condenser circulation, and a wide variety of transfer, chemical, industrial and general services. **—K–23**

Miniature Gearmotors

New permanent-magnet Type VS d-c gearmotors developed by Globe Industries, Inc., provide up to 35 oz-in. torque continuous duty, in a package having a frontal area as small as 0.4 sq in. Two configurations are available; namely, the end-mounted reducer provides 62 ratios from 7.88:1 to 25,573.65:1 and the side-mounted reducer provides a chose of 27 ratios from 26.93:1 to 2511.84:1. The end-mounted reducer and VS motor is $^7/_{16}$ in. × $^7/_8$ in. ×$3^3/_4$ in. maximum length, depending on ratio chosen; typical weight is 2.5 oz. Side-mounted reducer and VS motor is $^7/_8$ in. × $^7/_8$ in. × $2^1/_4$ in. long; typical weight is 2.5 oz. Spur-gear system uses case-hardened gears on hardened stainless-steel shaft.

Units are designed to meet appropriate MIL specs. Standard motor has 13 standard armatures for up to 50 volts d-c; motor rated 0.0025 hp at 8000 to 17,000 rpm. **—K–24**

Diamond developed for more economical power...

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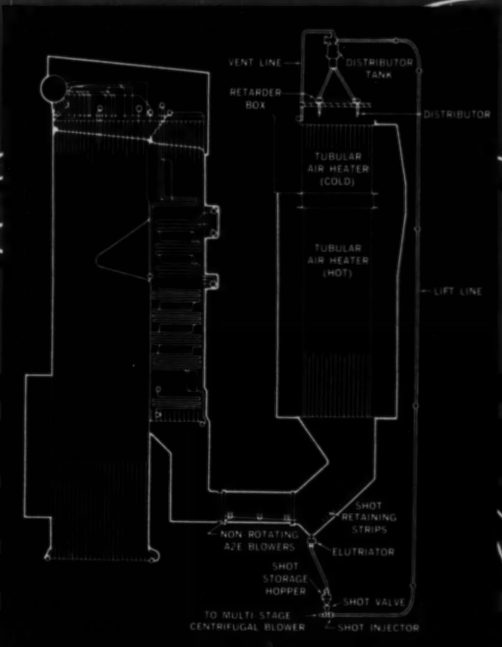
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DISTRIBUTOR
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SHOT RETAINING STRIPS
NON ROTATING AZE BLOWERS
ELUTRIATOR
SHOT STORAGE HOPPER
SHOT VALVE
TO MULTI STAGE CENTRIFUGAL BLOWER
SHOT INJECTOR

General arrangement of Diamond Shot Cleaning System now being installed on Penna. Electric's Shawville Station Steam Generating Units No. 1 and 2. System has 135 foot lift system . . . highest installation yet using standard equipment.

To maintain constantly clean airheaters, thereby minimizing draft losses and reducing annual outage time, Pennsylvania Electric Company is installing Diamond Shot Cleaning Systems on Shawville Station Steam Generating Units No. 1 and 2. Because Diamond Shot Cleaning Systems consistently have proved to be highly effective for this difficult cleaning application, Pennsylvania Electric anticipates significant savings through elimination of unpleasant manual cleaning and the costly boiler downtime that goes with it.

The selection of Diamond Shot Cleaning is typical of Pennsylvania Electric's continuing effort to achieve greater power generating efficiency. It also demonstrates the growing acceptance of a totally new concept in cleaning waste heat, recovery, and power boilers that defy cleaning by conventional methods. At your request, our engineers will be happy to discuss the application of Diamond Shot Cleaning to your new or existing steam generator. Call, write or wire.

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Write for our New Engineering Catalog 60

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WARREN, PENNSYLVANIA, U.S.A.

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NEW EQUIPMENT
BUSINESS NOTES
LATEST CATALOGS

Clip-On Fastener

Elastic Stop Nut Corp. of America Type LHA4972 is a new "clip-on" self-locking fastener design offering substantial cost saving opportunities for such aircraft applications as attachment of flooring, sound proofing, and fairings. It can also be used effectively for many other types of sheet-metal or fiber-glass assemblies for missile and electronic end-use as long as the 0.020 in. thickness of the clip can be tolerated between the mating surfaces. For such applications it replaces many varieties of fixed or floating anchor or plate-type nuts which must be riveted to the sheet. The cost of riveting is eliminated and the ease of removal or replacement is an additional advantage.

An important feature of the ESNA design is a locating eyelet formed on the base plate which snaps firmly into the hole drilled or punched in the sheet. The shape of the eyelet and the spring tension of the clip design insure that the fastener will not shake loose from the assembly during transportation in the shop and prior to insertion of the screw. Type LHA4972 is manufactured from carbon steel; available inventory size 10–32, other sizes in design. Locking torque and tensile per MIL-N-25027. **—K-25**

Gage Isolator

A gage isolator, designed to prevent gage damage for pressure surges in all types of hydraulic circuits, is being offered by Sarasota Precision Products, Inc., a subsidiary of Racine Hydraulics & Machinery, Inc.

The sub-plate mounted gage isolator is a normally closed, spring-returned, three-way valve. Depressing a push button opens the pressure line to the gage to permit reading. When the button is released, the gage is isolated from pressure and drained to the reservoir. The device acts as an effective snubber to prevent gage damage caused by pulsations, chatter and fluid hammer. Accurate gages prevent damage to hydraulic components, molds, dies, and the like.

Gage isolators, also available with $^1/_4$-in. NPTF ports for in-line mounting, are available for operating pressures to 5000 psi and can be used with any hydraulic oil and other noncorrosive fluids. **—K-26**

Dust Collector

Graver Water Conditioning Co., Div. of Union Tank Car Co., has issued literature on its "Atomix" mechanical dust collector. The principle on which this collector functions is the selective acceleration of dust particles i.e., collection of largest particles at lowest velocities, and smaller particles at higher velocities, providing high collection efficiencies with a minimum of abrasion.

Details of design, construction, and applications are given. **—K-27**

Heat Exchanger

A heat exchanger has been developed by the research laboratory of Brown Fintube Co. which incorporates a bundle of fintubes into a high-pressure, hairpin-type shell. The new exchanger is suited for high-pressure operations up to 6000 psig in the tubes and 1800 psig in the shells.

Prior to the development of this exchanger the benefits of multi-fintube designs have been limited to low-pressure applications for the shellside and tubeside fluids (500 psig). The advantages of using a bundle of fintubes over the conventional single tube in a double-pipe exchanger is that it increases capacity substantially permitting a reduction in the cost of sizing many jobs. It is stated that one multi-fintube unit with its higher heat-transfer capacity can replace as many as four conventional units.

Some of the other major uses for these new exchangers are for light fluids such as light hydrocarbon products, chemicals, and high-pressure gas coolers. High-pressure multi-fintube exchangers are made in 4-in. shell size and are also available with bare tubes for services which require no fins. Request Bulletin No. 112. **—K-28**

Cutting Tool

A rotary oxygen-torch cutting machine said to reduce the cost of preparation for welding by as much as 45 per cent has been developed by the Foster Wheeler Corp.

The machine, which is used in making marine boiler steam drums, is a portable device whose purpose is to prepare the cylinders for the attachment of elliptical drum ends.

It burns through the ends of cylinders that cannot be rotated on turning rolls, the company explained. It replaces a conventional machining operation that took about three times as long to cut through 4 or 5 in. of steel.

The unit is equipped with casters for primary positioning and jacks for anchoring and leveling. **—K-29**

Hydraulic Pumps

Hydreco Div., The New York Air Brake Co., has announced a new series of heavy-duty, gear-type, hydraulic pumps designed to meet the demand for higher operating pressures on large mobile and off-the-highway construction equipment.

Designated the 3000 A series, these gear pumps are rated at from 40 to 95 gpm at 1800 rpm for fluid power systems to 2000 psi and 2500 psi, and operating speeds to 2800 rpm.

Available with standard SAE mountings, this series is easily adapted to all types of applications on heavy-duty mobile equipment; such as dump trucks, bulldozers, cranes, front-end loaders and scrapers where dependability, efficiency, and ruggedness are of prime consideration. **—K-30**

KEEP INFORMED

NEW EQUIPMENT
BUSINESS NOTES
LATEST CATALOGS

Gas Valve

A new valve, developed to meet the stringent reliability, leakage, and vibration requirements of today's high-pressure gas systems has been introduced by Valcor Engineering Corp. Incorporating a number of advances in valve design, the V-38700 Series meets the challenge of high flow under intense high pressures beyond 3000 psi.

The V-38700 series features extremely clean internal flow passage, thus insuring minimum pressure drop. Plumbing connections are considerably simplified by a special coaxial configuration. The main poppet seal is a resilient Teflon ring. When the valve is opened, a pressure differential is created that actually forces the seat out of the path of foreign particles in the gas stream. When the valve is closed, the Teflon is prevented from cold-flowing by an overlapping metal seat. The O-ring seals are designed to shrink tighter as the temperature decreases.

After cycling, maximum leakage of 4 cc per hr is standard. Electrical response times below 0.020 sec are possible with special solenoids, and drop-out voltages above 3 volts d-c are standard. The solenoid contains an adjustable drop-out spring. The weight is 1.1 lb for the $^3/_4$-in. size. **—K-31**

POSEY

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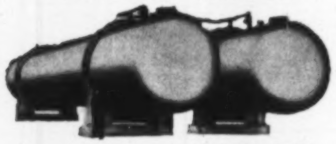

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Heat Exchanger

Basco, Inc., has made extensive strides in the utilization of O-ring seals in shell-and-tube heat exchangers. This has resulted in development of an externally packed floating head of improved design which is a standard feature on all Basco Type OP exchangers.

Basco's double O-ring seal permits the tube bundle to expand and contract without harmful strain or intermixing of shell and tubeside fluids. The O-rings retain compression without adjustment and are unaffected by vibration or temperature changes.

The new removable tube bundle Type OP heat exchangers are rugged, thermally efficient, and are available with shell diameters from 6 through 16 in. They are suitable for many applications including oil or water cooling of internal-combustion engines, compressors, steam and gas turbines, reduction gears, bearings, and electrolyte cooling for liquid rheostats. One and two-pass models, with a variety of nozzle locations, are assembled from standard parts assuring quick delivery. Illustrated Bulletin 0-1162 available. **—K-32**

BUSINESS NOTES

Beryllium Co. Expansion

A multi-million dollar plant which boosts beryllium metal fabricating capacity of the Brush Beryllium Co. Cleveland, Ohio, by 50 per cent has started production. The facility, when completed later this year, will represent a $3 million investment in plant and equipment and will replace three smaller fabricating locations the company operated in Cleveland.

Brush president George S. Mikhalapov said that the new 90,000-sq-ft plant "greatly enhances our efficiency in turning out finished beryllium metal parts." He called the new plant "one aspect of an integrated effort at Brush to bring the cost of beryllium down while increasing production capacity to meet growing demands."

Other aspects of the effort cited by Mikhalapov were Brush's pioneering of new markets for beryllium and its recent announcement that the metal had been produced for the first time from ore mined from recently-discovered U. S. sources.

The new Cleveland plant (located on St. Clair Avenue at about East 178th Street) is part of an over-all expansion program under way at Brush.

Brush, world's largest producer and fabricator of beryllium products, also opened a new 28,000-sq-ft plant last year near Reading, Pa., for the precision rolling of beryl-

GRAY BIMETALLIC PIPE PROVIDES CORROSION RESISTANCE AT FRACTION OF THE COST OF SOLID ALLOY SYSTEMS

Gray Bimetallic pipe provides all the fabrication and strength advantages of carbon steel with the corrosion resistance of the best alloy materials, and at a fraction of the cost of a solid alloy system.

In the Gray process, a seamless lining is hydraulically expanded into the base pipe, forming a tight bond due to differential contraction of the materials. For all practical purposes the bond is permanent. Bimetallic pipe can then be fabricated almost as easily as carbon steel. It can be butt welded, flanged and bent without damage to the lining or the bond.

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NEW EQUIPMENT BUSINESS NOTES LATEST CATALOGS

lium copper and other alloys, and a new beryllium metal-machining plant in Hayward, Calif., to serve missile and aircraft manufacturers along the West Coast.

New H. K. Porter Subsidiary

H. K. Porter Co. Pittsburgh, Pa. has announced the purchase of the National Cornice Works, Inc., Los Angeles, Calif. The firm is primarily a manufacturer of fans and blowers used for commercial and industrial ventilation, and marketed under the "Master Fan" trademark.

National Cornice Works, nearly half a century old, will be operated as a wholly-owned subsidiary of Porter. Its engineering and sales forces will work closely with those of Peerless Electric Div. of H. K. Porter Co. at Warren, Ohio. National Cornice is one of the largest producers of industrial size fans and blowers on the West Coast. For the future, Porter is currently studying plans for additional machinery and equipment that would increase fan and blower production capacity at National Cornice Works by as much as 50 per cent.

LATEST CATALOGS

Air-Powered Equipment

Lincoln Engineering Co. has published a 32-page catalog on air-powered equipment for materials dispensing applications. Equipment shown in Catalog 42 includes pumping systems to dispense paint, cold roofing materials, food materials, calking compounds and sealers, mastic adhesives and glues, vinyl material for plastic molding, inks, underbody coatings, sound deadeners, and similar fluid or semifluid materials.

Specifications are given on Lincoln "Power-Master" pumps, dispensing accessory units, measuring valves and airless hydraulic "Dyna-Spray" units and their accessories. Also listed are hose, air controls, couplers, nipples, and adapters needed for systems. **—K-33**

High-Pressure Washers

"Aquablast" high-pressure washers, manufactured by John Bean Div., Food Machinery and Chemical Corp., are described and illustrated in a folder now being distributed.

These washers discharge water under 600 psi or more at the given nozzle, making it possible for one operation to accomplish as much as a crew of men using city water pressure of 50 psi. **—K-34**

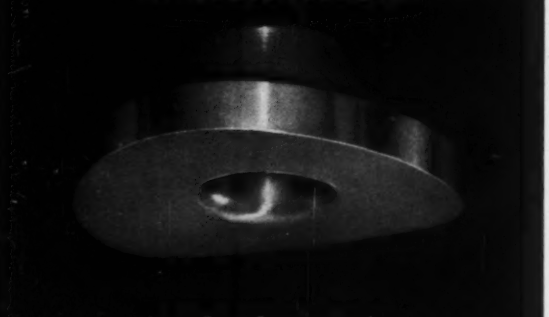
Add-Subtract Controllers

The Dynapar Corp., subsidiary of Louis Allis Co. has recently published a bulletin, No. 202-A, on "Add-Subtract" digital process controllers and totalizers.

Add-Subtract digital process controllers provide direct-reading numerical indication of bidirectional counting or measuring operations and also actuate automatic machine control functions. Add-Subtract digital totalizers provide numerical indication only.

Typical machine applications include cutting to length, positioning, balancing, drilling, coil winding, and the like. **—K-35**

ANTICIPATION



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High strength steel connections — contour forged and machined to exacting measurements — built to last under extreme pressures — these are the requirements of America's modern aircraft carriers. In anticipation of the ever-changing needs and new applications of military and industry, Lenape constantly searches for improved pressure vessel connection designs of all types.

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MECHANICAL ENGINEERING

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BUSINESS NOTES
NEW EQUIPMENT
LATEST CATALOGS

Filter Aids

Eagle-Picher Co. in a well-illustrated bulletin deals with the production of diatomaceous silica which meets the highest standards of quality and uniformity as filter material. A table of suggested grades of "Celaton" filter aids for a wide variety of industrial uses is included. **—K-36**

Rotary Valve

Precision built rotary valves for feeding dry bulk materials, or for use as an air seal, are described in a new four-page bulletin, No. N-261, released by the DAY Co.

The two color brochure details construction features of DAY Type "A" and Type "B" valves. It includes application photographs, specifications, dimension charts, and diagrams. **—K-37**

Heating and Ventilating

A comprehensive engineering catalog for large heating and ventilating units and heat diffusers has been produced by Carrier Air Conditioning Co. The 32-page catalog contains easy-to-read selection charts for steam and hot water coil capacities, fan-motor ratings and dimensional data for all models and sizes produced by Carrier.

The units, which are designed for commercial buildings, schools, churches, auditoriums and other large spaces, provide heating from 47,000 to 2,990,000 Btu with air capacities of 1,500 to 32,000 cfm. **—K-38**

Space Heaters

A new line of industrial forced-air space heaters, designed for use in buildings where frequent air changes are necessary, has been described in Dravo Corp. Bulletin No. 580-14.

Called the "Directflow" heater, the gas-fired unit is particularly suited to industrial plants where noxious gases, acid fumes, dust or hot vapors are released as part of the manufacturing processes and expelled by exhaust fans.

The Directflow has no combustion chamber and handles only nonrecirculating makeup air. Combustion occurs in the air stream, with resultant gases emitted into the plant with heated outside air. However, these gases represent less than 0.001 per cent of the total volume, or less than 10 parts per million—a safety margin much greater than the standard of 100 ppm set by both the U. S. Bureau of Standards and the American Conference of Governmental Industrial Hygienists.

The unit is available in seven models, ranging in air output capacity from 11,000 cfm to 60,000 cfm and in heat output up to 6,750,000 Btu/hr, with a maximum turndown ratio of 25 to 1. **—K-39**

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NEW EQUIPMENT
BUSINESS NOTES
LATEST CATALOGS

Surge Arrestor Valve

A 16-page Bulletin W-16 describes the Golden-Anderson Valve Specialty Company cushioned surge arrestor valve which anticipates the surge to protect the system. Pilot controls automatically open the main valve on abnormal pressures, subnormal pressure, or electrical power failure. **—K-40**

Clamp Assemblies

Accurate Bushing Co., has just released a 12-page catalog, No. JF-61, on its clamp assemblies and fixture components line.

The catalog contains complete information and drawings of the more than 1000 ABC clamp assembly and fixture component items that are availabe from factory stock. A price list is also available. **—K-41**

Steel Belt Conveyors

Sandvik Steel, Inc. offers a new 16-page illustrated book on steel belt conveyors, entitled "Pictures of Conveyors in Action." The brochure contains sections on bulk conveying, piece goods conveying, work tables, and water bed conveyors for cooling materials in transit.

An introductory section describes flat, troughed, longitudinally jointed, and perforated steel belt conveyors, tabularizes available belt sizes, includes a detailed line drawing of a typical installation, and tells where steel belt conveyors may be obtained. Remaining sections are devoted to illustrations of typical installations. **—K-42**

High-Temperature Alloys

A booklet on high-temperature, high-strength alloys, which are used in the aircraft, aircraft-engine, gas-turbine, missile and any other applications where corrosion resistance, and high strength at elevated temperatures are needed, is available from Allegheny Ludlum Steel Corp.

Actually, the new high-temperature booklet features a series of steels and alloys, each with its own individual leaflet, together with a 28-page general booklet on high-temperature alloys. While all the materials are treated in the general booklet, each steel or alloy is treated in detail in the accompanying individual leaflet.

The general booklet classifies the families of high-temperature steels and alloys into iron-base, nickel-base, iron-nickel base, cobalt-base, and the cobalt-chromium-iron-nickel alloys. Also included are high temperature alloy graphical charts, test data, machining data, and test procedures. The individual leaflets give much the same data in much greater detail on the particular material covered. **—K-43**

Pipe Welder

A four-page brochure has been released by Air Reduction Sales Co. on its latest welding development— the Aircomatic pipe welder.

The new automatic welder—using the Aircomatic (gas metal-arc) CO_2 welding process— brings production speed to pipeline welding without the need of pipe rotation. All phases of weld completion, form joint preparation to the finished weld, are accomplished by one simple setup.

Liberally illustrated, the brochure covers all the salient features of the new Airco development; how the process works, the practical advantages and the equipment required. A full page of photographs, showing the unit in test operations in the Odessa oil field of West Texas, is of particular interest. **—K-44**

NEW OPENING

Offering Unusual Career Potential

PUMP DESIGN ENGINEER

. . . over $10,000 salary bracket

One of the nation's leading manufacturers of products for the industrial, consumer and defense markets has a recently created position for an experienced centrifugal Pump Design Engineer. This position offers outstanding personal as well as professional potential with a company not now engaged in the manufacture of pumps, but of advanced systems in which pumps—(10 to 1500 hydraulic h.p. range)—are incorporated.

RESPONSIBILITIES

You will assume full technical responsibility for pump design and development, and for providing pump application data on these designs. You will also provide consulting services to engineers designing the systems in which your pumps will be used.

QUALIFICATIONS

BSME together with an MS (or the equivalent in experience). Minimum experience requirements include 5 to 10 years with a pump manufacturer—preferably in fluid mechanics and/or centrifugal pump design. You must also be able to meet and favorably impress our customers.

Location is in the Northeast. You will have full access to computers, extensive testing facilities, consultants and laboratories.

Qualified applicants will be invited to visit our facilities at Company expense. Relocation assistance will be provided. Additional information about our extensive benefits program for employees and dependents will be provided.

Please include enough information about your education and experience to justify further consideration for a position of this salary and responsibility level. All qualified applicants will be considered for employment without regard to race, creed, color or national origin. SJ-549A

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345 E. 47th St., New York 17, N. Y.

KEEP INFORMED

NEW EQUIPMENT
BUSINESS NOTES
LATEST CATALOGS

Control Valves

"Control Valves" is the subject of a 64-page bulletin available from Fisher Governor Co. This comprehensive manual fully describes Fisher pneumatic diaphragm and piston actuators, and a wide variety of valve-body assemblies. A 20-page specifying section contains the information necessary for selection of a control valve. Accessories, such as valve positioners, handwheels, electro-pneumatic transducers, and so on, are also included.

Among the topics are a discussion of valve-body and trim materials, a description of various styles of valve plugs, pressure-temperature ratings, maximum pressure drop tables, and performance data including frequency response. Completely illustrated and easy to read with many tabulations and listings. **—K-45**

Tolerance Rings

The Roller Bearing Co. of America has issued a catalog giving complete technical details for application of "Star" tolerance rings. The tolerance ring is a corrugated, open ring of hardened steel, with straight rims at the ends of the corrugations. It serves as a wedging shim between two cylindrical members.

Due to its elasticity the Star tolerance ring allows wider tolerances and maintains its grip under varying conditions of temperature, load, alignment, and so forth. It can be used to fasten related parts, to transfer torque, etc. It provides low-cost assembly by eliminating threads, keyways, and set screws; it provides self-alignment and divergent rates of expansion of related parts without losing its grip on them. It is inexpensive, effective and fool proof.

Typical applications include, holding anti-friction and plain bearings, bobbins, cams, couplings, fans, gears, impellers, knobs, pulleys, pins, spacers and wheels, and so on. **—K-46**

MPT Equipment

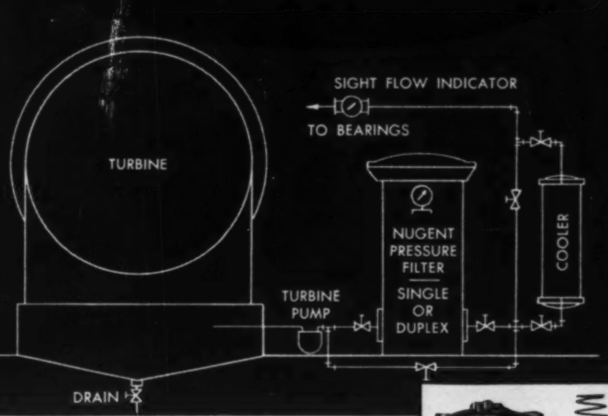
An eight-page bulletin, No. 23102, titled "Mechanical Power Transmission Equipment is a condensed catalog of many products and also a useful index to T. B. Wood's Sons Co. trade literature. Each product or product line description is concluded with reference to a separate bulletin for detailed information, drive selection tables, etc. The catalog covers briefly V-belt, ultra-V and FHP drives, timing-belt drives, flat belt pulleys, variable-speed drives, cotton card and cotton cleaner drives, motor bases, flexible couplings, bushings, bearings, pillow blocks and related equipment. **—K-47**

Air and Hydraulic Cylinders

Bulletin 10C describing its Series A2 pneumatic and hydraulic cylinder line is being distributed by the S-P Mfg. Corp.

With the aid of a cutaway cylinder illustration, S-P's important engineering developments—both in cylinder construction and operating advantages—are fully detailed. The Series A2 cylinder line, rated at 250 psi air and up to 2400 psi hydraulic, is available in 11 bore sizes from $1^1/_2$ through 14 in. with 25 mounting styles and a wide range of piston-rod diameters. **—K-48**

LUBRICATING OIL FILTERING SYSTEMS for GAS TURBINES



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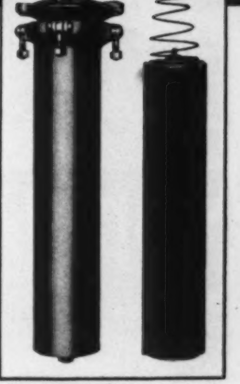

Fig. 1555-4L filter and laminated disc cartridge provide excellent micronic efficiency.

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Circle No. 99 on Readers' Service Card

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NEW EQUIPMENT
BUSINESS NOTES
LATEST CATALOGS

Flexible Couplings

Several types of high-speed heavy-duty flexible couplings for power transmission are illustrated and described briefly in Bulletin 135 being distributed by Thomas Flexible Coupling Co., a subsidiary of Koppers Co. **—K-49**

Automatic Filter

A bulletin on the Graver Monovalve filter, a fully automatic gravity filter with a single, simple control valve, is now available from Graver Water Conditioning Co., Div. Union Tank Car Co.

The literature, Bulletin WC-130, describes the construction, operation and applications of the filter, which stores its own backwash water and is available in single or multicompartment units. Operating on the loss-of-head principle, which assures automatic backwashing of the filter beds whenever they reach a predetermined "dirtiness," the filter requires minimum maintenance and attention and provides a reliable source of uniformly pure filtered effluent at all times. **—K-50**

C-Frame Press

Two bench-type and one floor-type C-frame presses, produced by H-P-M Div. Koehring Co., are detailed in Bulletin 58-CPM of recent issue. With manual control these presses have capacities of 5, 10, and 15 tons, respectively. General press specifications and dimensional data are included. **—K-51**

Storage Water Heaters

Bulletin No. 1234 of The Patterson-Kelley Co. describes a line of storage water heaters.

The eight-page bulletin lists storage and heating capacities, dimensions, and material thicknesses for vertical and horizontal water heaters of plain steel, copper silicon, copper lined, and Pre-Krete lined.

A separate section provides information on P-K's new Scalefree 230 indirect gas-fired storage water heater, a completely packaged unit with storage capacities ranging from 250 to 4000 gal and recovery capacities from 390,000 to 2,215,000 Btu. Also included is a separate listing of other available catalog data on P-K heaters. **—K-52**

Autotransformers

General Radio Co. has issued an information sheet on its W30 Variac, a continuously adjustable transformer. It is available for back of panel mounting of encased models for bench or wall mounting. The new metered Variac for measuring power consumption, tracking down circuit troubles, and so on, in laboratory test setups and engineering work areas is also treated. **—K-53**

Boiler Cleaning

A 14-page technical bulletin detailing the various "Selectromatic" boiler-cleaning control systems has been released by Diamond Power Specialty Corp. The bulletin provides specifications, describes features of the standard control panels, and shows some of their possible combinations. It also shows many examples of custom-built control panels, demonstrating the wide range of special designs that can be developed by Diamond Power to meet individual customer needs. **—K-54**

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ACHIEVEMENT
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FLOW CONTROL
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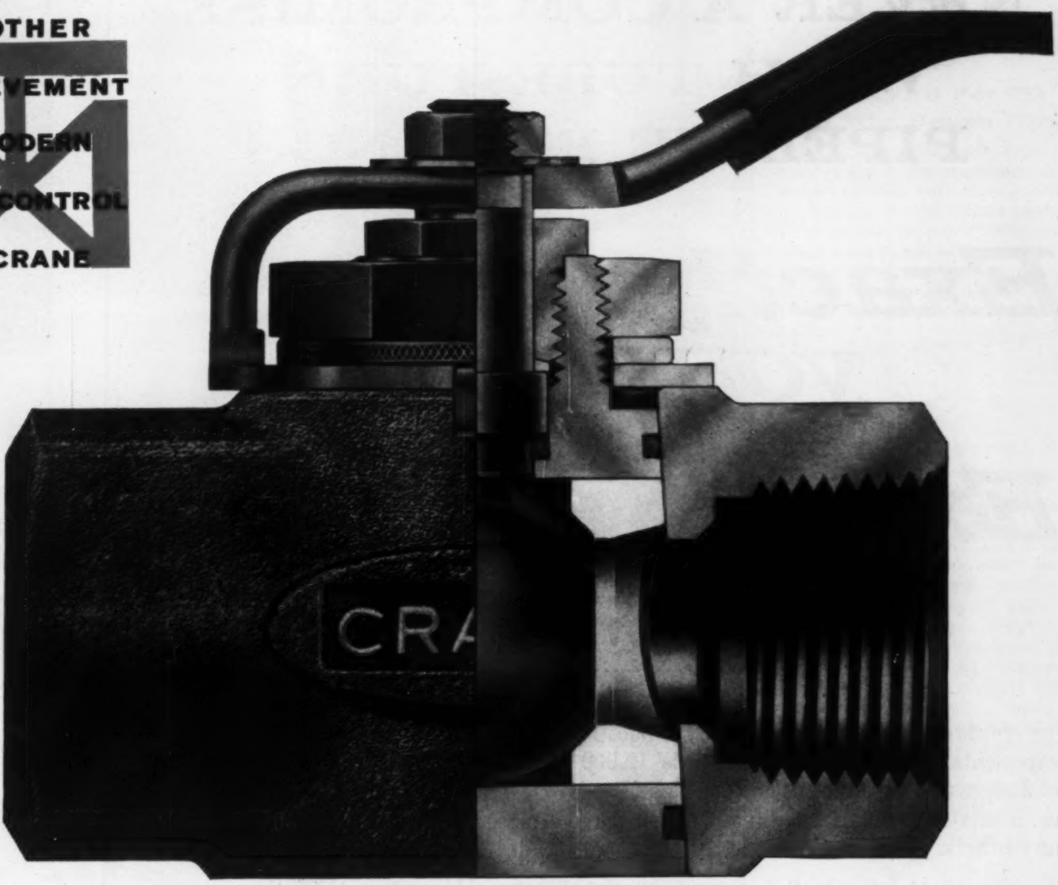

this ball beats all!

CRANE BALL VALVES are engineered for superior flow control and minimum-maintenance operation. The secret of this valve's all-around outstanding performance is its beautifully simple, Crane-designed tapered cartridge containing all the working parts. While the valve body remains in line, acting as a pipe connection, the entire cartridge may be removed from the bottom, quickly and easily, for fast exchange or simple, low-cost maintenance.

Precision pre-loaded Teflon* seats assure bottle-tight closing in either direction with a quick, easy quarter turn of the bright, Crane orange insulated handle. The self-aligning, precision machined ball is polished and chrome-plated to reduce friction and wear on the self-cleaning seats. All steel parts are plated for corrosion resistance. Crane Ball Valves handle fluid, gas and air services from vacuum to 800 psi and temperatures from −40 to 400F. Available now in sizes from ¼″ to 2″, screwed ends: bronze, carbon steel and Type 316 Stainless.

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Why compromise in pipeline design? Choose the exact pipeline components you need from Tube Turns' 12,000 standard fittings and flanges and pipeline specials such as 3R elbows, scraper bar tees, insulating flanges, manifold fittings, hinged closures, and many others.

Why compromise in pipeline construction? Your Tube Turns Distributor will fill all your pipeline component needs on a single order . . . no red tape, no delays. Tube Turns' prompt service keeps your construction timetable on schedule.

Why compromise in pipeline performance? To get all the performance you designed into your pipeline, make sure TUBE-TURN quality goes into the job, not merely into the design specs. Tube Turns Distributors and responsible contractors are glad to give you this assurance with an affidavit that states they have met your specifications to the letter.

Standardize on TUBE-TURN Pipeline Fittings now, and look for the famous "tt" trademark when you buy. It's your guarantee of quality . . . the mark of *known* value. Write today for TUBE-TURN Pipeline Fitting selection guide . . . ask for Bulletin TT638-K205. TUBE TURNS, Louisville 1, Kentucky.

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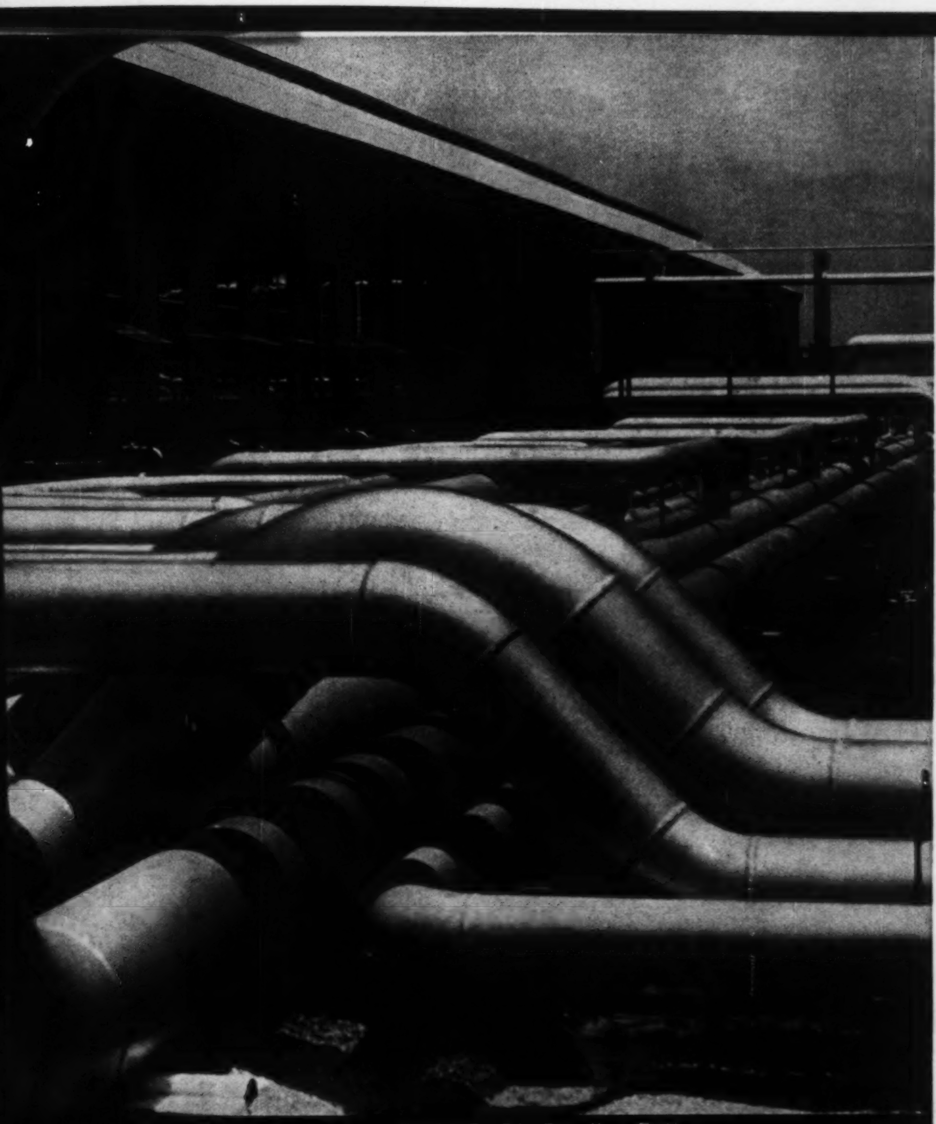

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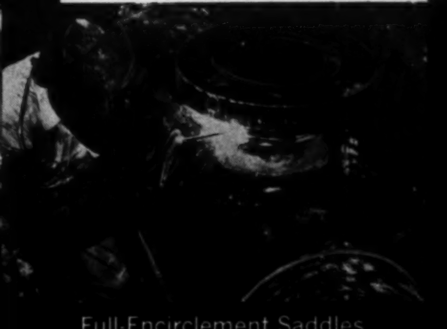
Time is money in pipeline construction. TUBE-TURN Pipeline Fittings do not require remanufacture or compromises . . . or the delays that result from rejections. They are uniform, precision-engineered for easy, time-saving installation. And you can put them in and *forget* them because they *are* dependable. TUBE-TURN piping products cost less because they save more in every way!

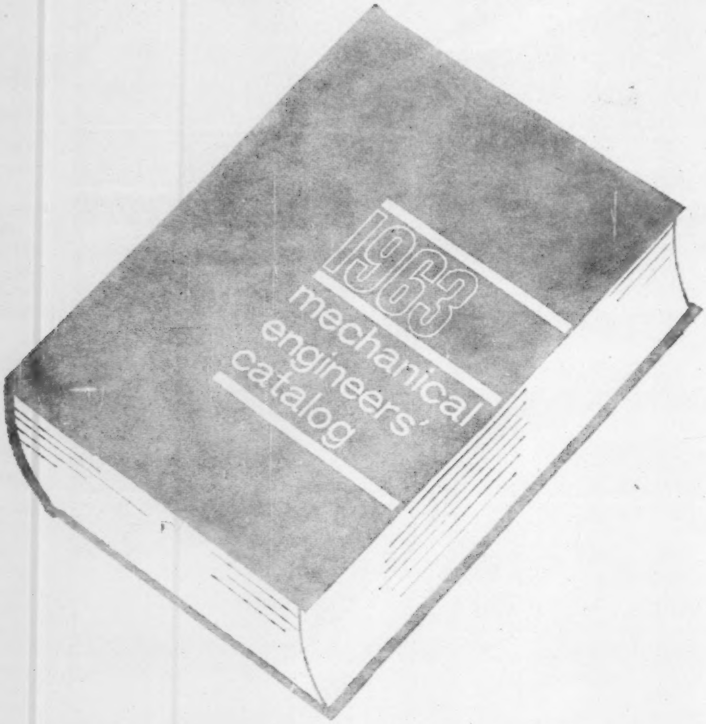
Anchor Forgings

Pig Diverter Laterals



Full-Encirclement Saddles

TUBE-TURN Pipeline Fittings Are Stocked By And Sold Exclusively Through Authorized Distributors



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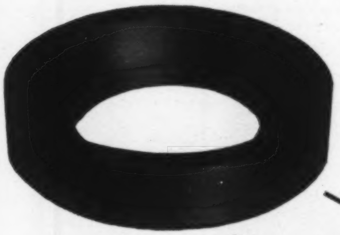
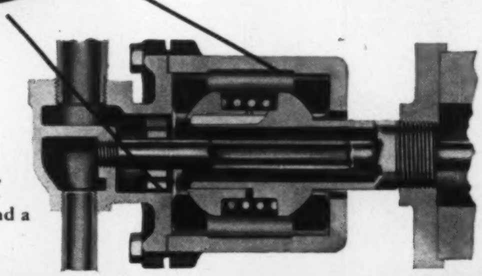
Superior performance and unusually long service life, even in tough applications, is practically second nature to parts made of GRAPHITAR. That's because they combine GRAPHITAR's chemical stability, heat resistance, low coefficient of friction, adaptability to self-lubrication, mechanical strength, hardness and light weight. An everyday application of GRAPHITAR that illustrates well its versatility and remarkable performance can be found in the face-type valves employed in bulk station gasoline meters. These valves incorporate GRAPHITAR seats.

Here, GRAPHITAR's corrosion resistance, chemical inertness and resistance to expansion or contraction under rapid temperature changes, allow the valves to provide a leak-tight seal with excellent wear characteristics. These same characteristics are necessary for good performance wherever steam, gas and chemicals must be handled under the most adverse conditions. Perhaps your product can benefit from the top performance of GRAPHITAR, a unique and versatile engineering material.





Self-aligning seals of GRAPHITAR are employed in rotary pressure joints handling steam, water, hot oil, trichlorethylene, powdered talc and a variety of chemicals.

R-302-1

Comparative testing of various grades of GRAPHITAR self-aligning seals is accomplished on this equipment, which duplicates actual operating conditions. GRAPHITAR rotary pressure joint seals such as these often operate at 400 psi, at 650 F. and at rotary speeds of 600 ft min.

GRAPHITAR is a material uniquely designed by its nature for solving tough problems and improving processing, and it can be further custom-engineered to meet your exact specifications. For complete information on GRAPHITAR . . . send for Engineering Bulletin #20.

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How to buy $25 bills for $18.75

It takes more than money to make their future secure. It takes long-range planning for them—and for America. That's why so many people buy and hold U.S. Savings Bonds.

In case you haven't heard, $25 bills are on sale at any bank. They're better known as U.S. Savings Bonds. The $25 variety costs you $18.75, and you can get them all the way up to a $10,000 blockbuster for just $7,500. These aren't the kind of bills you ordinarily use for groceries, of course. Most folks tuck them away to grow (they mature in 7 years, 9 months) and then cash them in for tuition, or a long vacation, or something else they want. Why not start buying them regularly?

SIX NICE THINGS ABOUT U.S. SAVINGS BONDS

• You can save automatically on the Payroll Savings Plan • Your Bonds earn 3¾%, ½% more than ever before • You invest without risk under a U.S. Government guarantee • Your Bonds are replaced free if lost or stolen • You can get your money with interest any time you need it • You save more than money—you buy shares in a stronger America.

An unusual coupon offer from the U.S. Government

Can they afford to buy money? He can set aside as little as $5 a week for Savings Bonds by signing a Payroll Savings application where he works. In a year they'll own Bonds worth nearly $350 at maturity, at a cost of $260.

You save more than money with U.S. Savings Bonds

They get better with age. Every Series E Bond is still earning money for its owner. An $18.75 Bond bought in May, 1941, will be worth $48.76 in 1971.

20th ANNIVERSARY 1941 1961

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FOXBORO
STABILFLO
VALVE

Now Foxboro gives you extra-high power plus long stroke...in one control valve motor

At last — a "fail-safe," spring-opposed pneumatic valve motor designed specifically for larger size control valves. Butterfly, Saunders, Stabilflo* valves — the new Foxboro "160" motor is designed for them all. In most cases, it replaces expensive pneumatic cylinder operators and positioners.

1½ to 4-inch stroke — linear relationship between input signal and valve stem position . . . weatherproof construction . . . selection of air-to-lift or air-to-close action. You'll want to know more about this motor. Ask your nearby Foxboro Field Engineer for full details or write for Bulletin 5C-17. The Foxboro Company, 9610 Neponset Avenue, Foxboro, Mass. *Reg. U. S. Pat. Off.

FOXBORO
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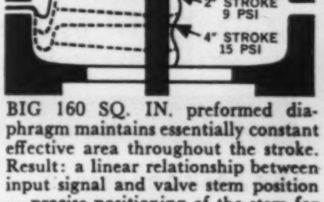
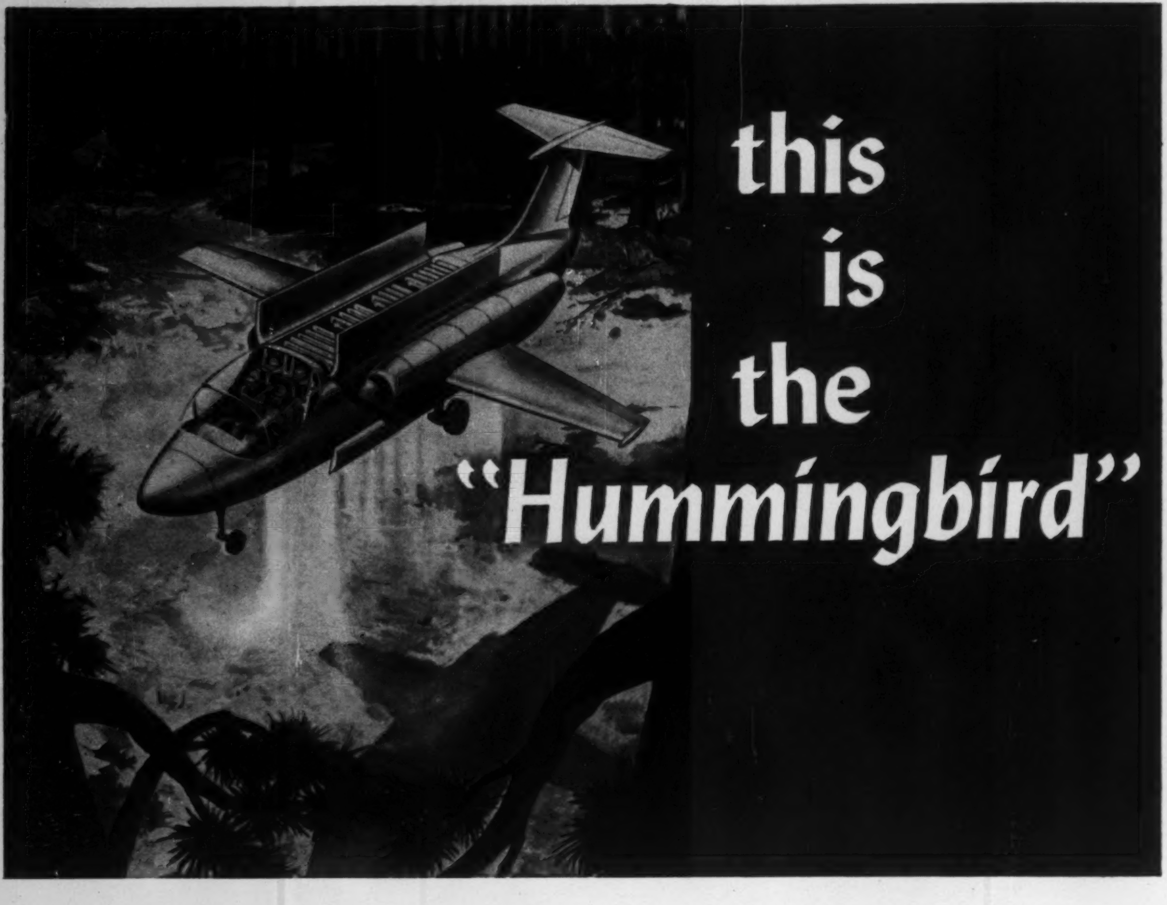


BIG 160 SQ. IN. preformed diaphragm maintains essentially constant effective area throughout the stroke. Result: a linear relationship between input signal and valve stem position — precise positioning of the stem for every signal change.

AIRCRAFT DESIGN ENGINEERS



Engineering is now underway on the strange looking bird pictured here. We call it the "Hummingbird," and we are developing it for the U. S. Army.

It is to utilize the jet ejector augmentation principle for VTOL aerial vehicles to fly straight up, straight down, hover in mid-air, and convert to conventional forward flying at speeds in excess of 500 miles per hour. Just one example of what is going on here at our Engineering Center where dreams come true. Like to join us?

Openings in the fields of: Aircraft Design Engineering • Engineering Drawings Checking • Aircraft Structures • Flutter and Vibration • Sonic Fatigue • Aircraft Specifications Engineering • Reliability Engineering • Operations Research • Aircraft Research Engineering.

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All qualified applicants will receive consideration for employment without regard to race, creed, color or national origin.

THE ENGINEERING CENTER
LOCKHEED-GEORGIA COMPANY
A DIVISION OF LOCKHEED AIRCRAFT CORPORATION

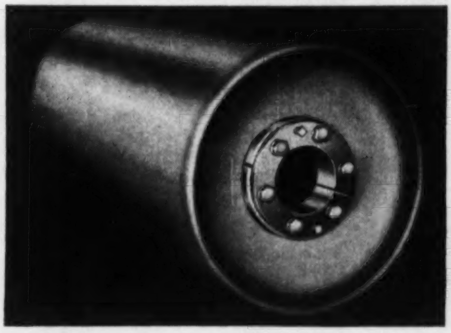
STEPHENS-ADAMSON

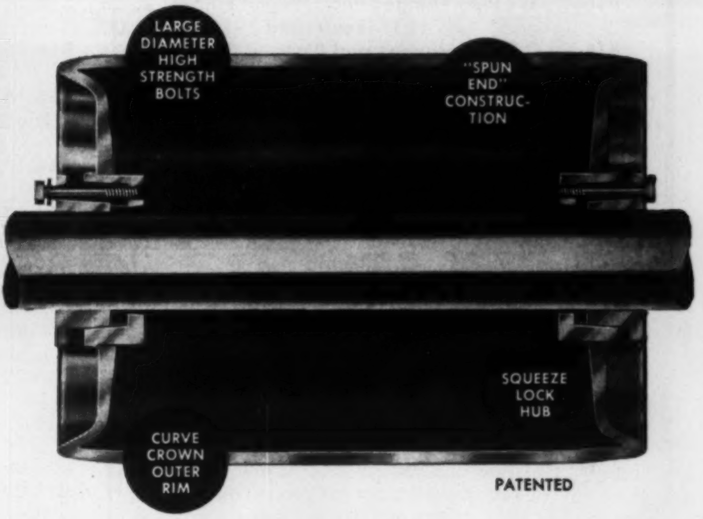
CURVE CROWN® BY STEPHENS-ADAMSON MFG. CO.

ONE PIECE ALL STEEL

PULLEYS

FEATURING EXCLUSIVE "SPUN END" CONSTRUCTION




LARGE DIAMETER HIGH STRENGTH BOLTS
"SPUN END" CONSTRUCTION
SQUEEZE LOCK HUB
CURVE CROWN OUTER RIM

PATENTED

"SPUN END" CONSTRUCTION

Exclusive, one-piece, all steel "Spun End" construction eliminates weldments in areas of high stress concentration, a major source of fatigue, warping and trouble. "Spun End" construction allows the placement of maximum metal thickness at end plate bore reducing unit pressures of radial loads while providing thin plate flexibility to accommodate shaft deflections.

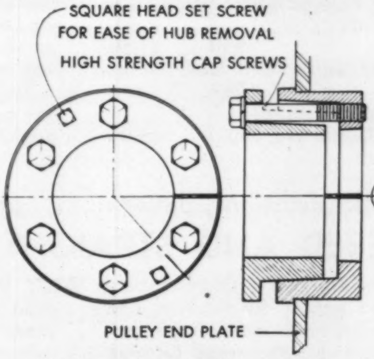
CURVE CROWN DESIGN

Accurately formed CURVE CROWN on outer ends of rim eliminates conventional center peak — a high point for belt stretch and wear — while increasing belt training effect more than 100%.

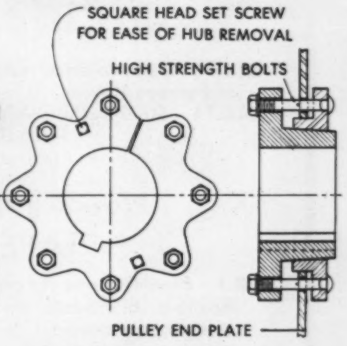
SQUEEZE LOCK HUB

Revolutionary SQUEEZE LOCK Hub design effectively transfers loads from rim to hub and from hub to shaft. Hub design provides gripping power for full torque transmission without the use of keyways and eliminates distorting loads against pulley "Spun End." The SQUEEZE LOCK Hub accomplishes this by exerting equal locking forces in two directions — to both shaft and pulley end plates — through a self contained hub. The outer bushing expands against pulley end plate, while the inner bushing contracts against shaft by tightening six large diameter, high strength bolts.

OUT PERFORMS ANY PULLEY EVER BUILT


SQUARE HEAD SET SCREW FOR EASE OF HUB REMOVAL
HIGH STRENGTH CAP SCREWS
PULLEY END PLATE

SQUEEZE LOCK Hub furnished with STANDARD CURVE CROWN "SPUN END." Pulleys from 1" thru 4½" bore.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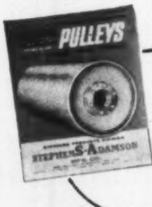
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This 1961 edition corrects many of the errors in the 1957 Standard, clarifies certain paragraphs to a better understanding of the standard, incorporates in its tables the pressure-temperature ratings for Types 304L and 316L flange series, has added an index, and includes the pressure-temperature ratings for non-ferrous flanges as a supplement. 1961 $3.00

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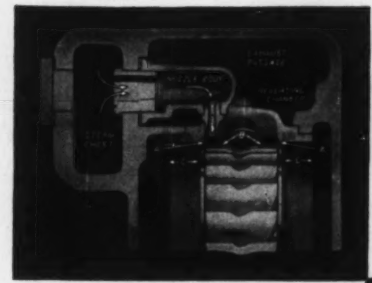

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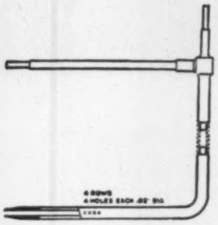

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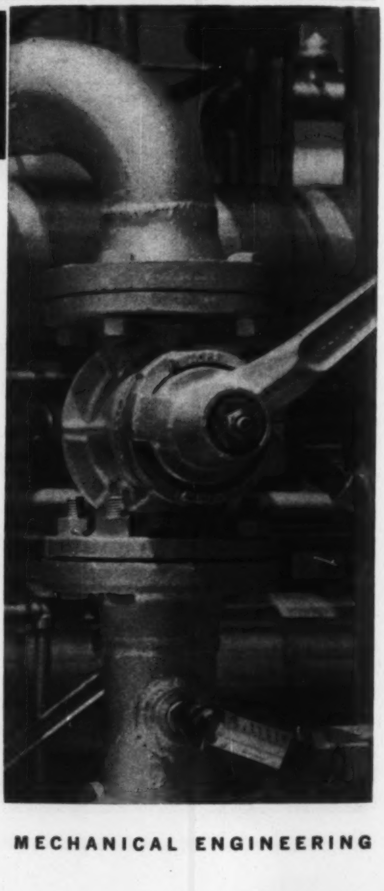

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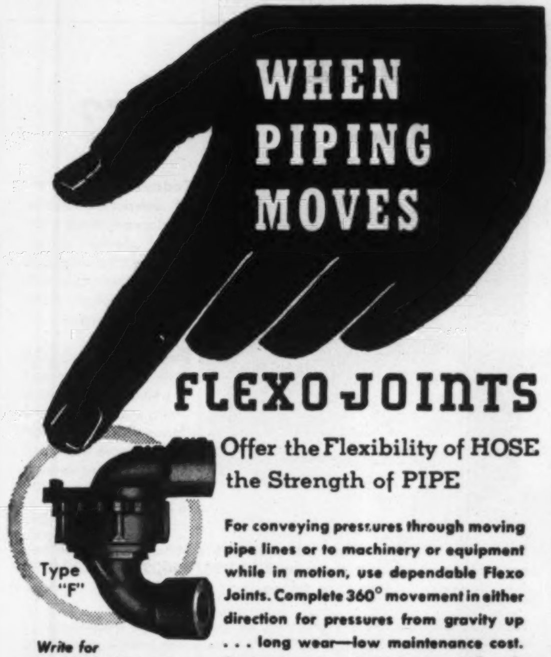

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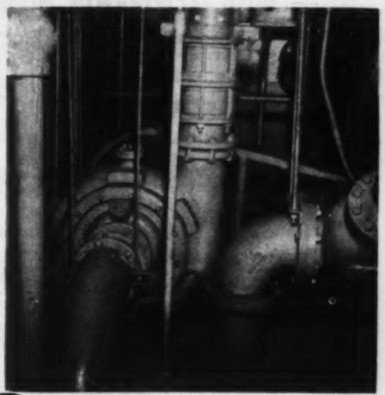

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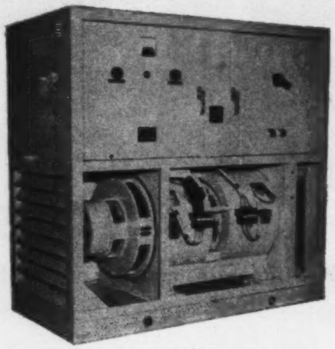

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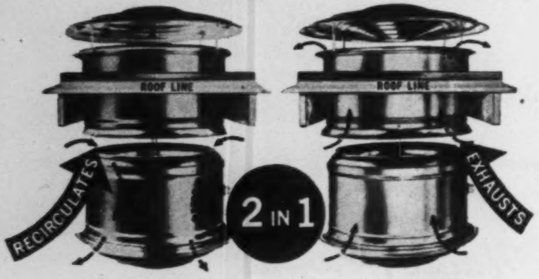

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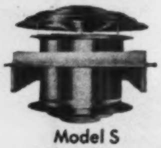

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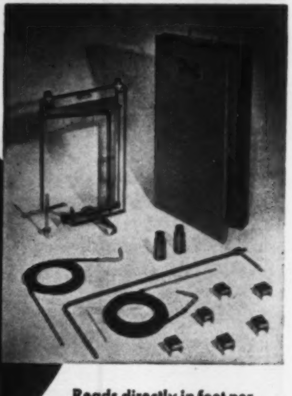

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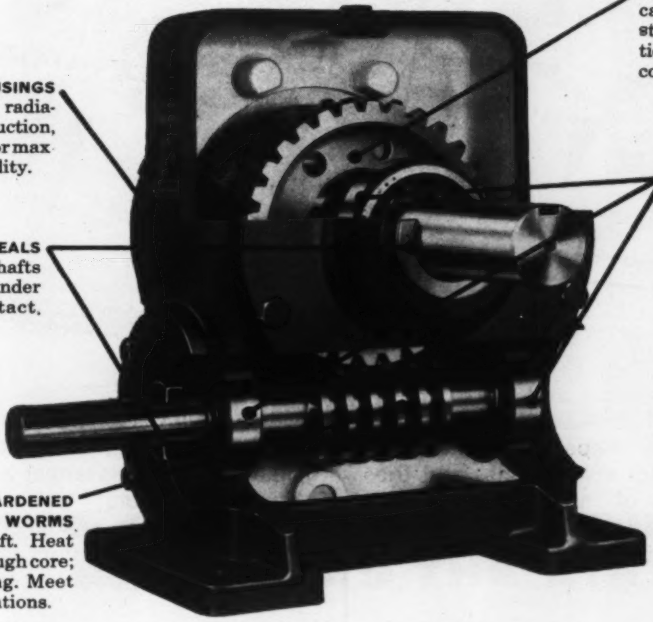

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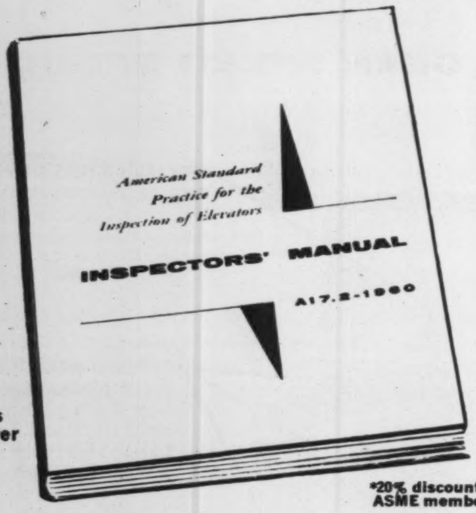

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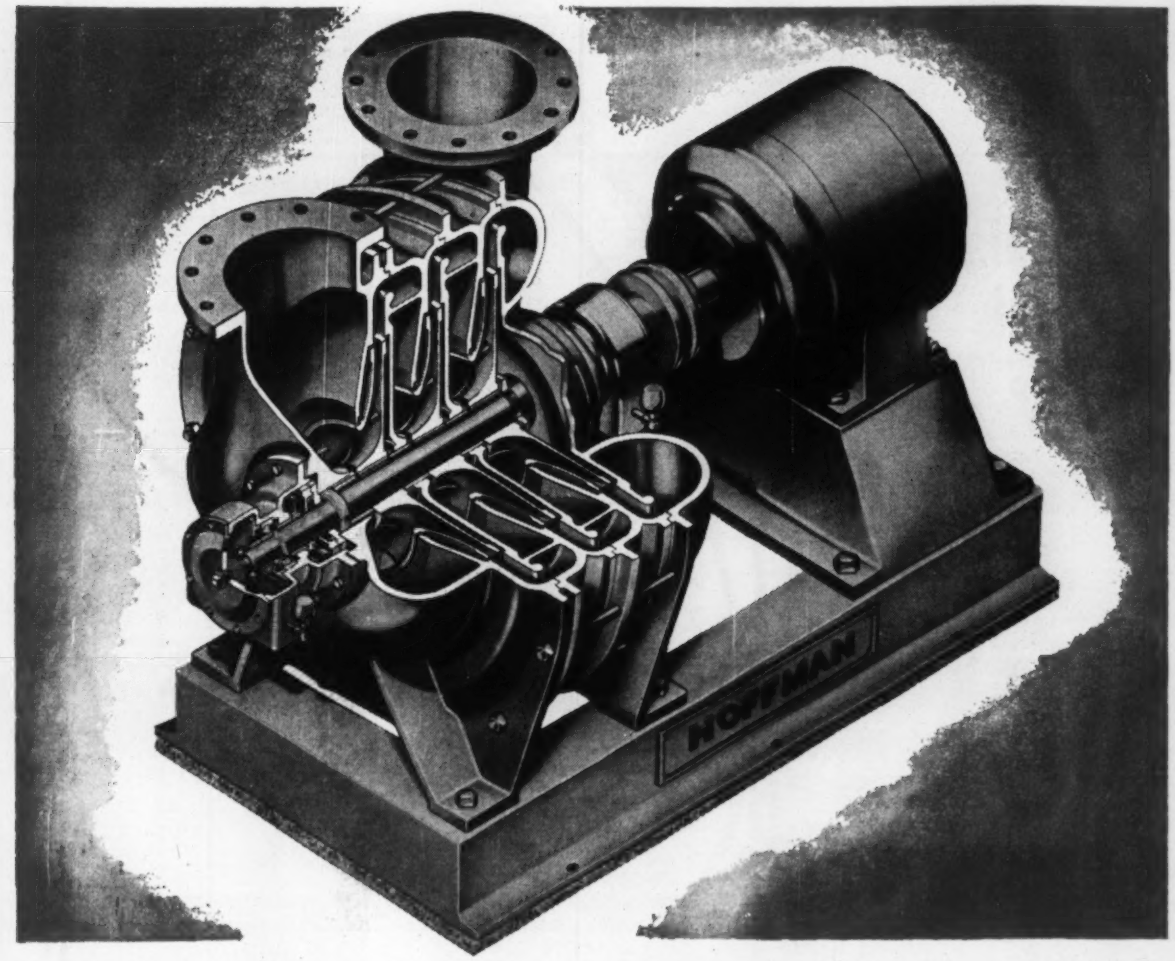

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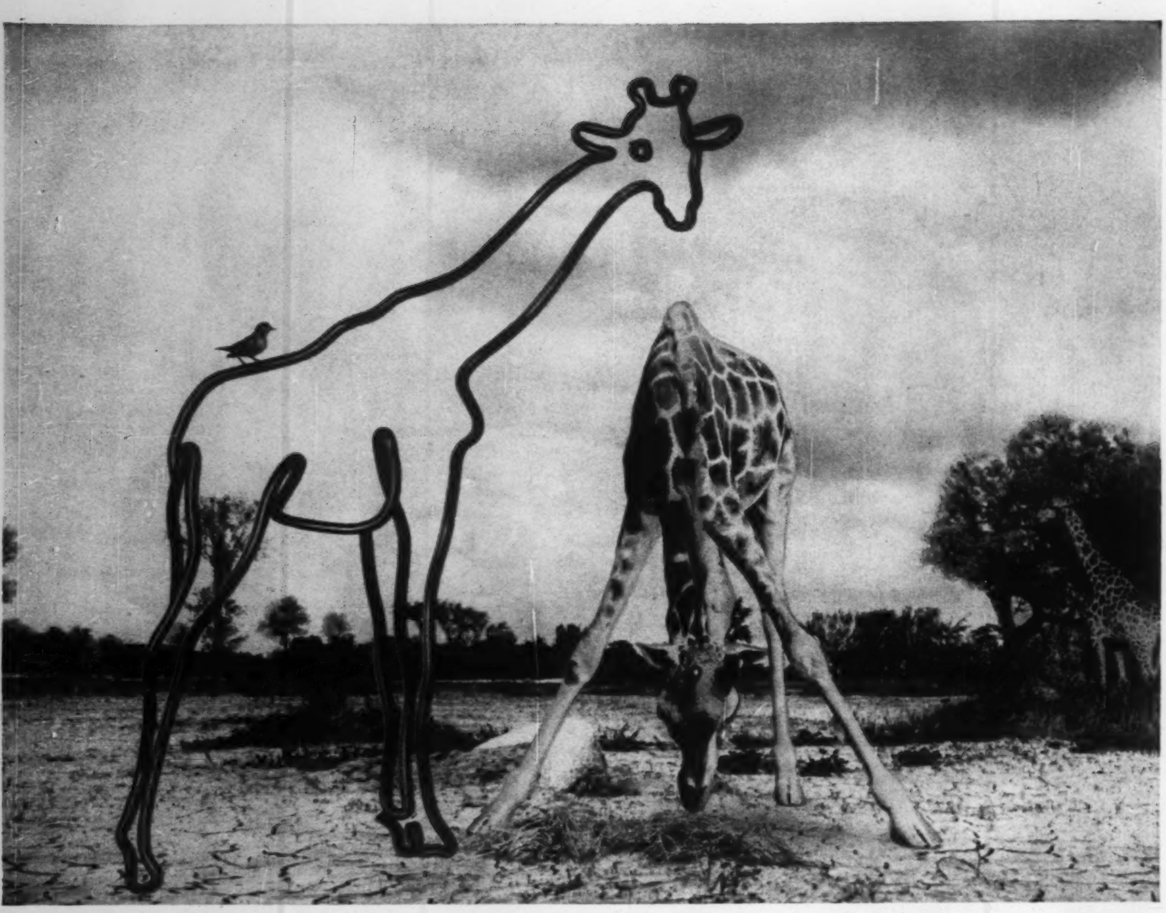

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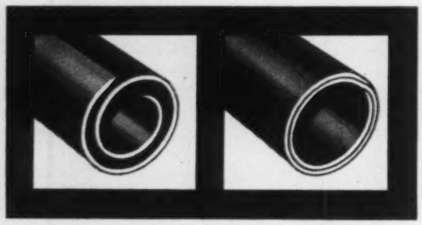

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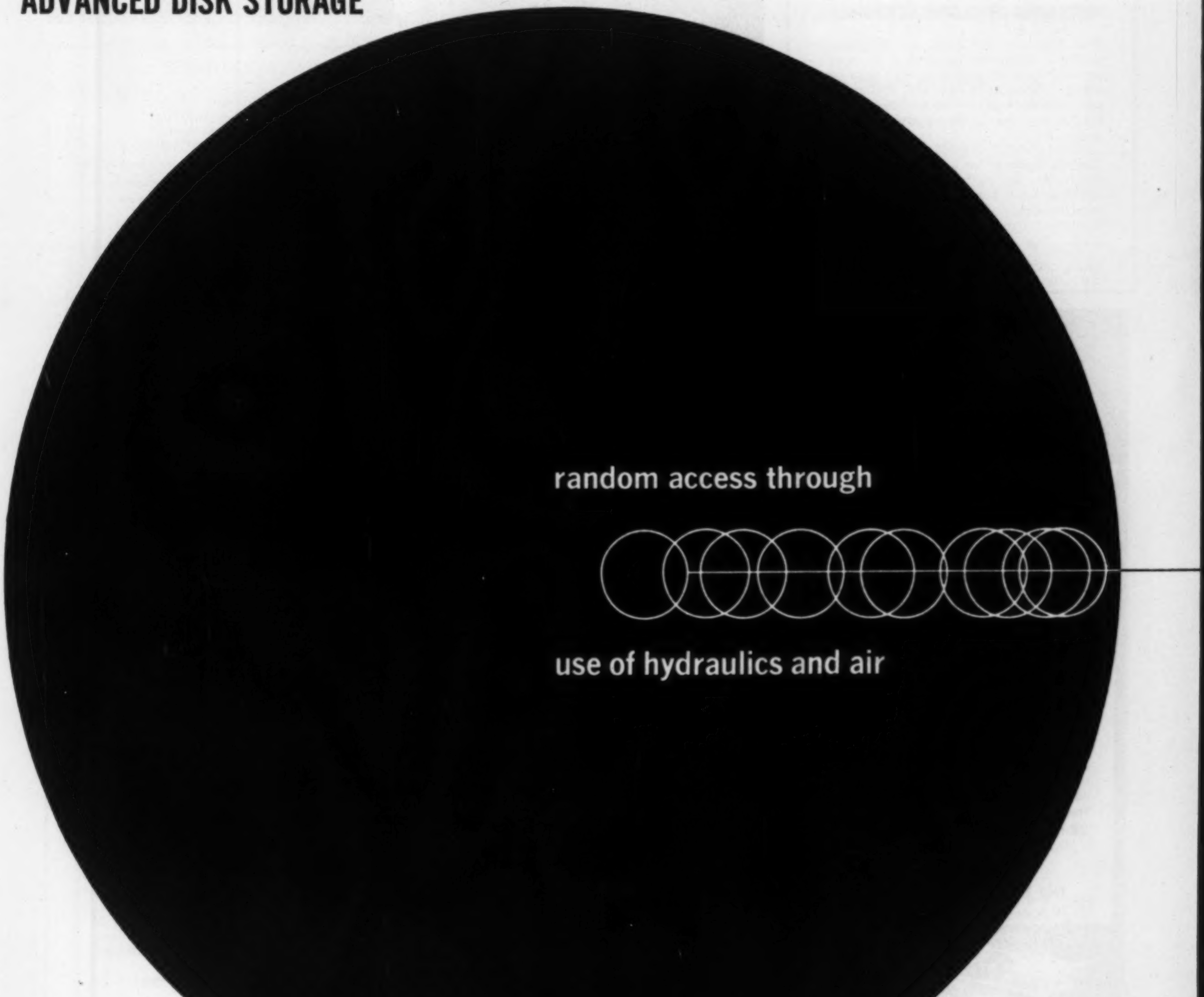
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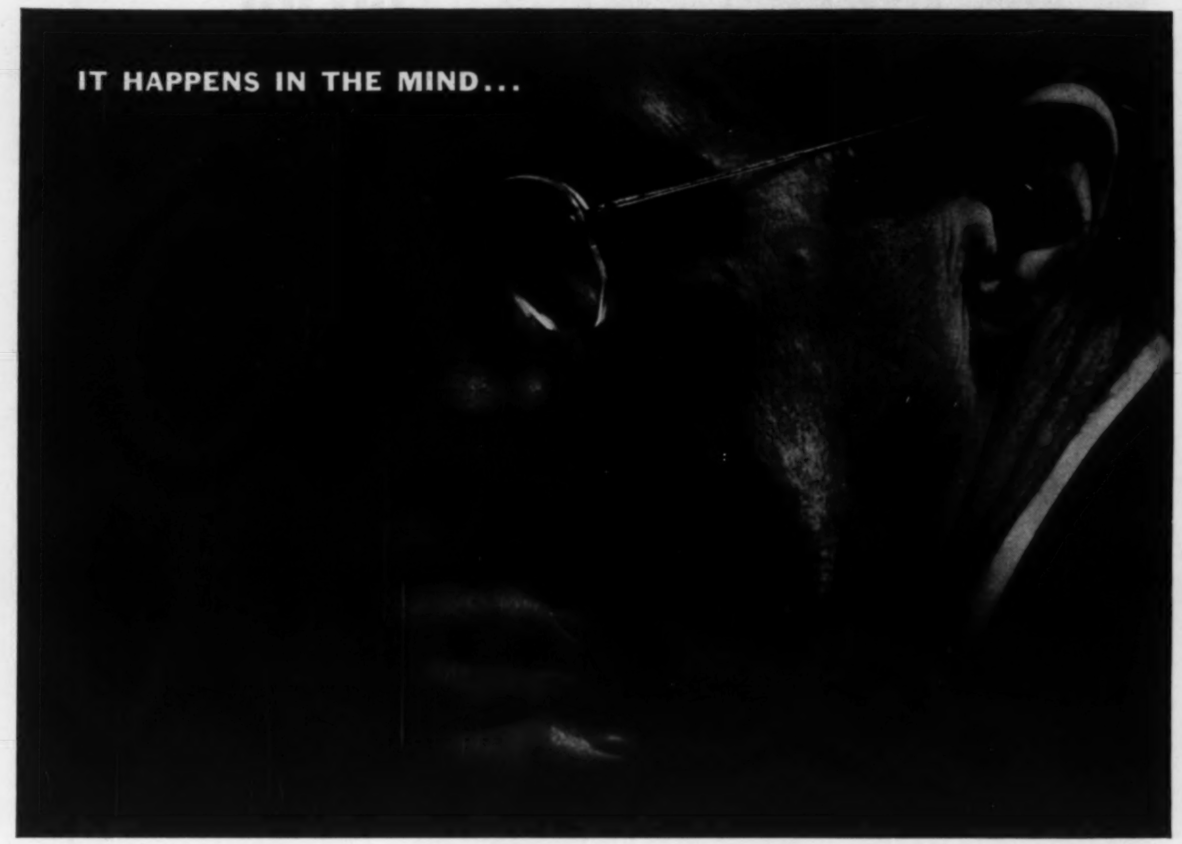
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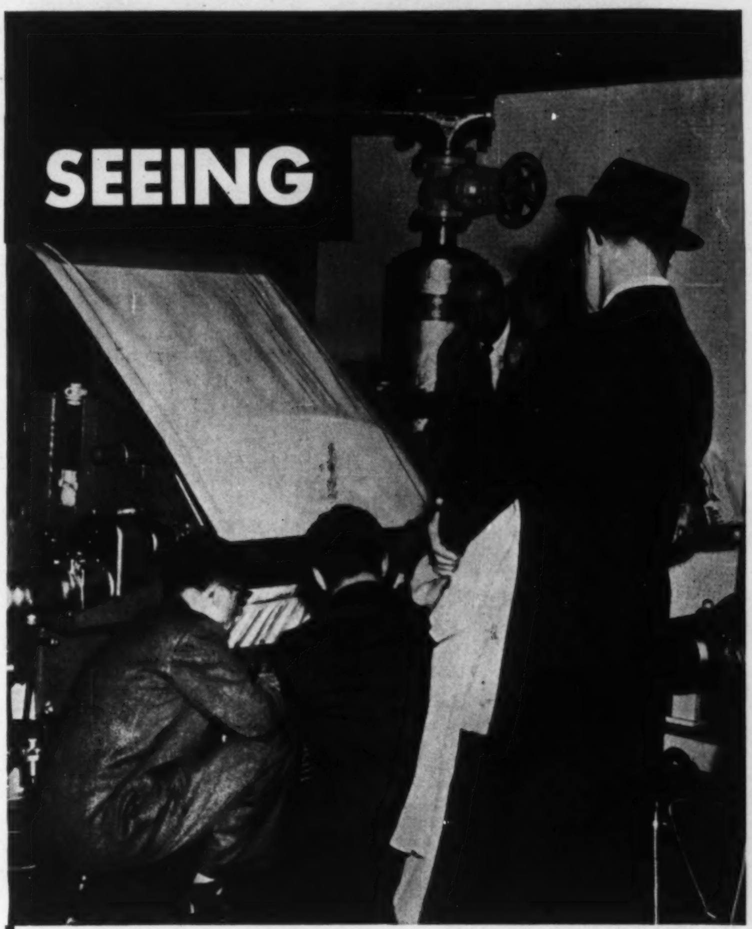

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This compact unit, 15" x 16" by 24" high, is powered by 115 volts AC and can provide day-in day-out instant solution of your most vexing engineering problems. Even if you have never seen a computer before, you can learn to operate the TR-10 as easily as you learned to use a slide rule.

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Because of its minimum size and low price, the TR-10 can become your own personal analog computer. You gain first-hand experience with the power of analog techniques, and convert more of your time to *creative engineering.* New ideas that were too costly to try before are now practical. You can design virtually to perfection and have a permanent, visual record of performance before building pilot models or prototypes. As a result, "cut and try" expense is reduced.

The same quality workmanship and design that has made Electronic Associates the world's leading producer of precision general purpose analog computers will be found in this new unit. Accuracy to ±.1 per cent. Modular construction allows you to select varying quantities of the following computing functions: summation, integration, multiplication or division, function generation, parameter adjustment, logical comparison.

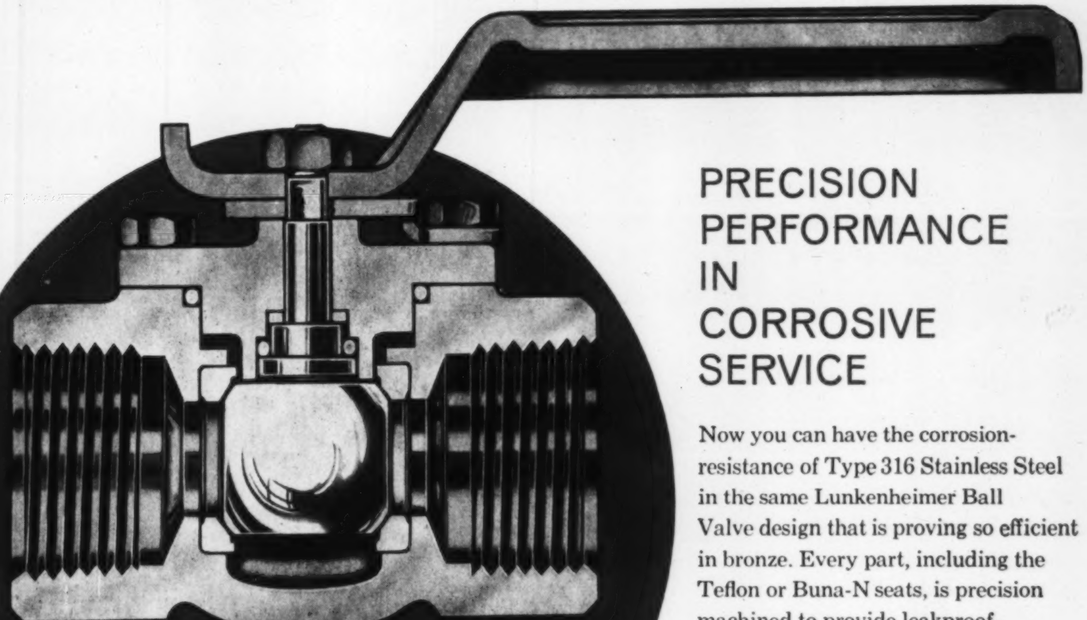
For complete engineering data, write for Bulletin TR-10 .

EAI

ELECTRONIC ASSOCIATES, INC.
Long Branch, New Jersey

Circle No. 48 on Readers' Service Card

NEW LUNKENHEIMER STAINLESS STEEL BALL VALVE



Figs. 704-T and 704-B—TYPE 316 STAINLESS STEEL—SIZES ¼" to 2"
TEFLON OR BUNA-N SEATS AND SEALS

- TOP ENTRY FOR EASY IN-LINE MAINTENANCE
- QUARTER-TURN OPERATION
- SELF-ALIGNING BALL
- STRAIGHT-THROUGH FLOW
- COMPACT DESIGN
- LOW OPERATING TORQUE

PRECISION PERFORMANCE IN CORROSIVE SERVICE

Now you can have the corrosion-resistance of Type 316 Stainless Steel in the same Lunkenheimer Ball Valve design that is proving so efficient in bronze. Every part, including the Teflon or Buna-N seats, is precision machined to provide leakproof performance in corrosive liquids, gases, and slurries. Corrosive atmospheres are no threat to solid Stainless Steel bodies and bonnets. Recommended for both pressure and vacuum applications.

LUNKENHEIMER®
THE ONE *Great* NAME IN VALVES
• BRONZE • IRON • STEEL • PVC

LUNKENHEIMER
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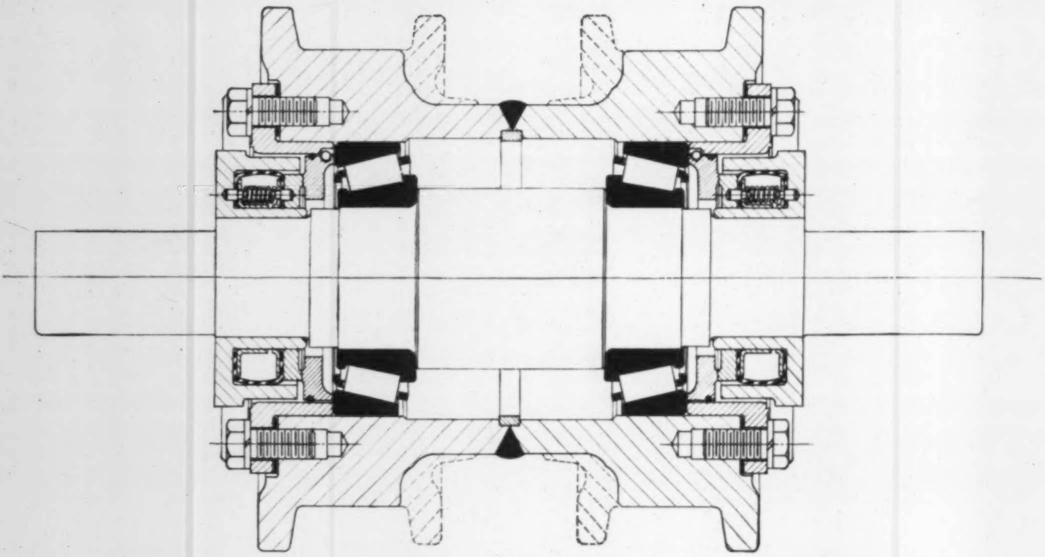
QUALITY

Get Circular 612 from your distributor or The Lunkenheimer Co., Cincinnati 14, Ohio.

L-561 24

Circle No. 86 on Readers' Service Card

How Allis-Chalmers reduces maintenance, boosts work capacity of their crawler tractors

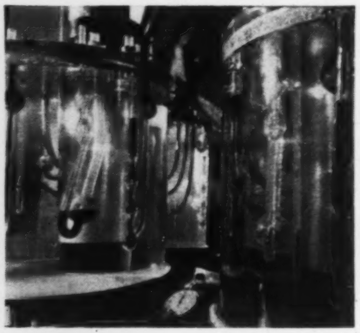


To design *both* greater work capacity and reduced maintenance into their crawler tractors, Allis-Chalmers engineers used Timken® tapered roller bearings for the heavy duty track rollers.

Timken bearings work with the steel sealing rings to effect a positive seal that makes one-time lubrication possible. Timken bearings keep all parts precisely aligned. They protect the seal by minimizing side thrust and wobble, eliminate wear that makes bushing-type assemblies impossible to seal positively. And the tapered design lets Timken bearings take *both* radial and thrust loads. Full-line contact between rollers and races provides extra load-carrying capacity—extra work capacity.

And to deliver more power where it's needed, Timken bearings are also used in the bevel and clutch shaft, final drive pinion, intermediate and sprocket shafts, track idlers and support wheels.

ENGINEERING ASSISTANCE, early in the design stage, helps manufacturers stretch bearing dollars. Timken bearing engineers have the training to do the job and are eager to help you.



METALLURGICAL LAB develops the steels that will make tomorrow's Timken bearings last even longer, help customers to design more economical and durable bearing applications.

Industry rolls on

TIMKEN®

tapered roller bearings

The Timken Roller Bearing Company, Canton 6, Ohio. Cable: "TIMROSCO". Makers of Tapered Roller Bearings, Fine Alloy Steel and Removable Rock Bits. Canadian Division: Canadian Timken, St. Thomas, Ont.

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